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WORLD SWORDFISH FISHERI

Volume IV.

Latin America

Part A. South America

Section 1. Pacific

Segment B. Chile

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

WORLD SWORDFISH FISHERIES

An Analysis of Swordfish Fisheries, Market Trends, and Trade Patterns
Past-Present-Future

Volume IV.

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Latin America

Part A. South America

Section 1. Pacific

Segment B. Chile

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National Oceanic and Atmospheric Administration
National Marine Fisheries Service
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The Latin American section of this study focuses initially on the Pacific coast countries of South America. Planned future volumes will cover other Latin American countries. The next planned set is the Atlantic coast South American countries (Argentina north to Venezuela). The authors are indebted to the many contributors throughout the region who supplied information and guidance. The individuals named here are primarily those who contributed to the South American Pacific chapters. Those individuals who have contributed to the Atlantic coast studies will be acknowledged when those chapters are published.

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Silver Spring, Maryland
September 30, 1997

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Personal Observations

Resource

"The Pacific is a big ocean. We may be able to significantly expand our catch. The fishermen are landing good sized fish averaging 300 pounds (135 kilograms)."
- Eduardo Neff, Empacadora del Pacífico (Chile), Summer, 1988

Development

"Chilean swordfish catches were minimal until the mid-1980s. The opening of the U.S. market, a IDB-funded fisheries development plan, and the introduction of modern gear enabled our artisanal and commercial fishermen to rapidly expand the fishery."
- Rodolfo Serra, Senior Scientist, IFOP (Chile), July 26, 1997

Decline

"The overall catch as well as the size of the individuals taken has clearly declined significantly in recent years. A variety of factors may be involved including overfishing as well as the apparent displacement of cooler waters further off the coast where it is more difficult for the artisanal driftnet fishermen to reach."
- Maria Angela Barbieri, IFOP (Chile), December 19, 1996

"The declining size of swordfish being landed is of great concern to the industry. The major reason for the decline may be substantial catch of juvenile fish by the longline fishermen."
- Javier Chong, Universidad Católica de la Santisima Concecpción (Chile), April 23, 1997

"Catches have plummeted in recent years. I think the major reason for this in the longline fishermen who large numbers of very small fish, sometimes as small as 20 kilograms. The Government needs to develop a more effective regulatory system."
- Jaime Azocar, Manager/Owner, Pesquera Santo Domingo (Chile), November 15, 1996

"One of the major factors in the decline of the swordfish since 1991 has been the massive effort deployed for the species. Not only did fishermen rapidly expand the fleet, but they have developed increasingly effective methods and gear."
- Eleuterio Yañez, Universidad Católica de Valparaíso (Chile), January 22, 1997

"There has been a startling decline in the size of the individual swordfish being landed here at San Antonio. I can remember seeing 450-kg fish, but now few fish are over 100 kg and some fishermen are landing very small fish.
- Gaston Clavería, Provincial Director, San Antonio, SERNAP (Chile), April 12, 1997

"The commercial longliners have had a detrimental impact on the swordfish fishery off the coast of Chile. These longliners take large quantities of swordfish and a large proportion of juveniles. This has caused the decline of the swordfish stocks off Chile (and thus the catch yields). This is one of the reasons that the artisanal fishermen targeting swordfish in Chile have to travel farther from shore to obtain acceptable catch yields."
- Adel Burgos, Administrative Assistant, APEVAL (Chile), January 27, 1997.

"I believe that the massive commercial effort on jack mackerel to supply fishmeal plants in recent years is one of principal reasons for the declining swordfish catch."
- Raúl Quezada Rodríguez, Asociación Greminal de Pescadores de Valparaíso (Chile), January 22, 1997

Domestic Fishermen

"Chilean artisanal fishermen have primarily deployed driftnets. Several artisanal fishermen are now considering longlines because of the declining yields in the coastal waters, especially inshore grounds, where they have deployed driftnets."
- Raúl Quezada Rodríguez, Asociación Greminal de Pescadores de Valparaíso (Chile), January 22, 1997

"Declining yields since the fishery peaked in 1991 has caused many artisanal and commercial fishermen to withdraw from the fishery. The declining yields in coastal waters has had a particularly serious impact on the artisanal fisherman who can not reach more productive offshore grounds with their small boats.
- Miguel Donoso, IFOP (Chile), December 20, 1996

Foreign Fishing

"I believe that the foreign fishermen active in the southeastern Pacific have had a serious impact on the swordfish stock. Some countries like Japan operate very large distant-water fleets."
- Heriberto Muñoz Concha, processing plant owner, November 20, 1996

"Spanish fishing in some years has been significant in the southeastern Pacific and unlike the Japanese they target swordfish."
- Hand Louis Schmidt, General Manager, Pesquera Omega, April 8, 1996

"Chilean authorities refuse to allow our fishermen to transship swordfish catches through their ports. This greatly impairs operations in the southeastern Pacific."
- Asociación Nacional de Armadores de Buques Congeladores (Spain), May 15, 1991

Government Officials

"We are very concerned about the sharp fall in swordfish catches since 1991. We have introduced new minimum size regulations in 1997 which we hope will help to reverse the catch decline. The regulations, however, only affect our fishermen and there are other countries targeting swordfish in the southeastern Pacific."
- Juan Manuel Cruz, Under-Secretary for Fisheries (Chile), July 25, 1997

"Chilean regulations permit foreign fishermen to transship fish through Arica in the north and Punta Arenas in the south. Foreign longliners do transship some tuna. The foreign fishermen, however, are not permitted to tranship swordfish because of the declining catches and difficulties experienced by our fishermen."
- Juan Rusque, SERNAP Director (Chile), April 2, 1996

"Our new VMS system is going to make a tremendous difference in our ability to monitor fishing operations at sea. Monitoring the swordfish fleet has always been a problem because of the distances they operate off the coast. For the first time we will have timely, reliable data on fishing operations which will enable us to better enforce fishing regulations. There are also many benefits to the fishermen, especially the safety factor."
- Alejandro Covarrubias, Director of Enforcement, SERNAP (Chile), July 26, 1997

Recreational Fishing

"There is currently no recreational fishery in Chile for swordfish and other billfish. Recreational fishermen have in the past reported spectacular catches off Chile. I believe that there may be the potential for developing a recreational fishery targeting these marvelous fish and other species."
- Juan Rusque, SERNAP Director (Chile), April 2, 1996

Markets

"Chilean companies process much of the catch, producing loins and other value-added product rather than merely shipping headed and gutted trunks. I believe we are the only Latin American country processing a large part of the swordfish catch."
- Jaime Azocar, Manager/Owner, Pesquera Santo Domingo (Chile), November 15, 1996

"The U.S. market appears to be increasing turning to whole, unprocessed trunks. Orders for processed value-added products have declined in recent years."
- Rodrigo Polanco, Subsecretaría de Pesca, September 22, 1997

Research

"IFOP is devoting considerable resources to swordfish research and is compiling a substantial data base. We are also cooperating with other researchers in other Pacific countries. The decline of the fishery since 1991 has been precipitous. We are hopeful that our institute is compiling will permit the Chilean Government to improve management of this valuable resource."
- Pablo Alvarez, IFOP Director (Chile), July 26, 1997

"We have made a good start on swordfish work here in Chile. A great deal of work, however, needs to be done before we can draw any firm conclusion about the status of stocks."
- Maria Angela Barbieri, Departamento de Tecnologia Pesquera, IFOP (Chile), January 29, 1997

"We conduct one of the most advanced remote sensing operations in Latin America, supplying our fishermen with oceanographic data helpful in locating areas most suitable for specific species. Our large small-pelagic fishermen make the greatest use of the data, but swordfish fishermen also find it very helpful in reducing time spent searching for the appropriate conditions."
- Jaime Arancibia, Systems Specialist, Space Studies Center (Chile), January 29, 1997

By-catch

"Actually, the by-catch from the artisanal driftnet fishery is much more serious than from the commercial longline fishery. Longlining is a relatively "clean" fishery with the target species constituting a relatively high percentage of the total catch."
- Han Louis Schmidt, Pesquera Omega (Chile), April 8, 1996

"The Chilean artisanal driftnet fishery for swordfish during the late 1980s probably was taking several hundred turtles annually may be taking several hundred turtles annually."
- Mauro Gonzáles Pino, swordfish vessel crew member (Chile), 1988.

"Leatherback turtle populations have declined sharply in the Pacific, especially since the mid-1980s. Nestings at Mexican and Costa Rican beaches have reached exceedingly low levels. I am currently assessing possible causes. The decline of the leatherbacks appears to correspond with the initiation of the current swordfish fishery in Chile. The artisanal driftnet fishery in particular may have has a devastating impact on the turtles."
- Scott Eckert, Hubbs Sea World Research Institute, September 26, 1997

Marine Mammals

"Interactions with marine mammals in the southeastern Pacific are very rare. I did once observe a killer whale off Chile. The whale followed us around the San Fernández Islands and then fed on the fins of sharks we had hooked. Another captain observed similar behavior."
- Ramon Salas, vessel captain, SIPESA (Peru), September 1, 1997

TO OUR ESTEEMED COLLEAGUES IN SERNAPESCA, IFOP, AND SUB-PESCA

1.4

CHILE

Chile continues to conduct the most important swordfish fishery in Latin America, despite significant reverses since the catch peaked in 1991. Swordfish, or "albacora" as it is usually called in Chile, is a resource of some, but fluctuating, importance to both the country's artisanal and commercial fishermen. Small-scale artisanal fishermen have taken limited quantities of swordfish with harpoons for centuries as there is archeological evidence that pre-Colombian indigenous peoples harvested the resource. Artisanal fishermen along the northern coast expanded a small existing harpoon during the 1930s-40s, responding to increasing demand in the United States. The artisanal fishery peaked during and immediately after World War II. Catches reached over 2,100 tons in 1946. The fishery then gradually declined as U.S. domestic production rose and reduced the need for imports and as the artisanal fishermen found more attractive employment opportunities in other fisheries and economic sectors. The fishery reached extremely low levels in the 1970s. The reasons for the decline are not fully understood, but the catch decline appears to be, at least in part, due to reduced effort, rather than a massive failure of the swordfish stock. Other then this brief period during and after World War II, Chilean catches have been minor and mostly for subsistence or local consumption. When restricted to the domestic market, relatively low prices provided little incentive for the fishermen to aggressively target the species, given the relatively low yields and rigors of harpoon fishing.

The Chilean swordfish fishery changed markedly in the 1980s as fishermen developed more efficient methods and foreign demand expanded. Exporters began entering foreign markets for high-quality fresh fish. Experiments with more productive gear and equipment began in 1982. The first trial swordfish shipments in recent years were reported in 1983. Fishermen rapidly adopted the improved fishing gear and methods which soon made it possible to expand harvests and significantly increase participation in export markets. The commercially oriented artisanal fishery thus developed as an export-oriented fishery, supplying fresh fish--primarily to the lucrative U.S. market. Shifting from labor-intensive, low yielding harpoons to more efficient drift gillnets enabled the fishermen to lengthen the season, target new grounds, and significantly increase fishing power. The artisanal fishermen primarily targeted coastal grounds along the central coast. Commercial fishermen, noting the success of the artisanal fishermen, began entering the fishery in the late 1980s. They acquired larger, more modern vessels and began deploying longlines. Other modern technology such as the use of satellite remote imagery to identify potentially productive grounds, have further increased the efficiency of fishing operations. The larger commercial vessels permitted extended voyages to offshore grounds, adding to fishing effort and pressure on the swordfish population. The commercial swordfish fishermen deployed freezer vessels and initially focused on frozen product. Government regulations prohibited the commercial fishermen from targeting coastal grounds which were reserved for artisanal fishermen. As a result, the commercial fishermen had to operate on offshore grounds where they reported substantial catches of relatively small, juvenile swordfish. Foreign longline fishermen have for years reported operations off the western coast of South America, some of it at latitudes off Chile--but beyond the 200-mile zone. These fishermen, primarily the Japanese, conducted a multi-species fishery focusing mostly on tunas, but also taking some swordfish. Spanish fishermen entered the Pacific longline fishery in the mid-1980s, specifically targeting swordfish. This further increased pressure on the population off Chile.

Annual swordfish catches have fluctuated markedly. The Chilean catch exhibits the classic boom-and-bust pattern often experienced in the development of new capture fisheries. Chilean fishermen rapidly increased the minimal catch of only 100 metric tons in 1984 to 7,300 tons at the 1991 peak. The Chilean 1991 catch was a larger

quantity of swordfish than is currently taken by all Latin American countries combined. Exports in 1991 may have totaled as much as $40 million, although sizeable unexplained discrepancies exist between Chilean export and foreign import data. Most of the Chilean exports are fresh fish which are shipped primarily to the United States. Chilean swordfish exporters have shown minimal interest in alternative foreign markets. At its 1991 peak, the swordfish fishery was the single most important edible fish caught by Chilean fishermen--generating profitable employment for both artisanal and commercial fishermen. Unlike most other Latin American countries which primarily exported unprocessed trunks, several Chilean companies processed swordfish products such as loins and fillets.

The Chilean fishery and processing activity has declined significantly since peaking in 1991 with a steady stream of lower annual catches each year. Government efforts to limit fishing effort through gear (artisanal and commercial) and area (commercial) restrictions have not succeeded in stopping the precipitous decline. Each year after 1991 the catch has fallen between 900-1,700 tons annually. The 1995 swordfish catch declined to less than 2,600 tons and export earnings reached only $21 million. This massive catch decline of nearly 65 percent since 1991 has forced the fishermen and companies involved to make a significant readjustment. Many fishermen have withdrawn from the swordfish fishery and re-rigged their vessels for alternative species. Much of the 1992-95 decline has been reported in the Chilean commercial fishery and by 1995 the artisanal fishermen were landing about 80 percent of the catch. As a result, the fishing effort by Chilean commercial fishermen on offshore juvenile fish by 1995 had declined to minor levels. Foreign fishermen also appear to have reduced their effort through 1995. Despite the reduced longline effort, catches of extremely small, juvenile fish continue. Overall artisanal effort has also declined significantly in recent years. The artisanal fishermen, who landed the bulk of the catch in 1995, also reported taking smaller fish--although not as small as the longline fishermen. The output of frozen swordfish has fallen sharply, primarily because of substantial declines in the prices for frozen product making it uneconomical to operate the large freezer longliners.

Several major developments occurred in 1996 which had a major impact on the swordfish fishery. The commercial fishermen had for several years been shifting to fresh fish operations--even companies operating freezer vessels. The higher prices earned for fresh product has reinvigorated the commercial fishery. As a result, the commercial fishermen in a dramatic shift dominated 1996 fishing for swordfish. At the same time, large numbers of artisanal fishermen withdrew, at least temporarily, from the fishery. Chilean fishermen reported the first annual swordfish catch increase in 6 years, taking over 3,100 tons. Most of the commercial fishermen was taken beyond the country's 200-mile limit--a distinct shift in grounds which had previous been mostly within Chilean waters.

The Chilean catch is still less than half of that reported at the 1991 peak, despite the 1996 increase. The reason for the sharp decline in the Chilean catch since 1991 is not fully understood, but it is likely that intensive fishing effort by Chilean and foreign fishermen is the principal reason. Many Chilean artisanal fishermen place the blame for the decline primarily on longline fishermen, both foreign and domestic, who take large quantities of juvenile fish in the offshore waters off Chile. It appears likely, however, that the greatly expanded artisanal fishery during the late 1980s and early 90s also affected the stock. The harvest of substantial numbers of small fish by the commercial fishermen before the fish mature sexually and reproduce may have been a key factor. Although some biologists would argue that the artisanal driftnet harvest of mature spawning fish may have been even more harmful. Climatic changes and other factors may have also affected stocks. The limited understanding of the swordfish stock structure in the Pacific, however, makes it impossible to make firm assessments. Annual results from the fishery, do show the classic indicators of overfishing. Government efforts to effectively manage the swordfish fishery is complicated by the lack of information on the Pacific swordfish stock structure and the limited biological data. The Sub-Secretaría de Pesca (SSP) has restricted fishing effort through gear limitations and a prohibition on new entrants. The SSP further restricted effort in 1997 by issuing new fishing regulations to protect juvenile fish. The potential impact on the commercial longline fishery which takes large numbers of juveniles could be significant.

The SSP has identified swordfish as a priority for Chilean researchers. The Instituto de Fomento Pesquero and associated Chilean universities have begun a substantial research effort to collect the data needed to better understand the stock structure and optimally manage the resource. IFOP's research program is the most significant swordfish research currently underway in Latin America.

The principal by-catch is sharks. Most are discarded, but the makos are retained. There is also a small incidental and poorly documented mortality of turtles, mostly leatherbacks. Some observers believe that the artisanal swordfish driftnet by-catch may have been a major factor in the decline of the species since the mid-1980s.

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I. Fishing Industry Overview

The expanding Chilean fishing industry is a leading sector of the national economy and has played an important role in Chile's recent economic success. The country's fishing industry in 1995 accounted for $1.8 billion in exports, an increase of 30 percent over the $1.4 billion exported in 1994 (appendix J1a). Fishery exports contributed over 10 percent of Chile's overall export earnings during 1995.[1] Results in 1996, however, were little changed and continued near 1995 levels. Companies were in part hampered by modest catch declines reducing the supply of raw material.

Photo 1.--Artisanal fishermen deploy a wide range of vessels and land most of the country's edible fish. Dennis Weidner

A. Fleet

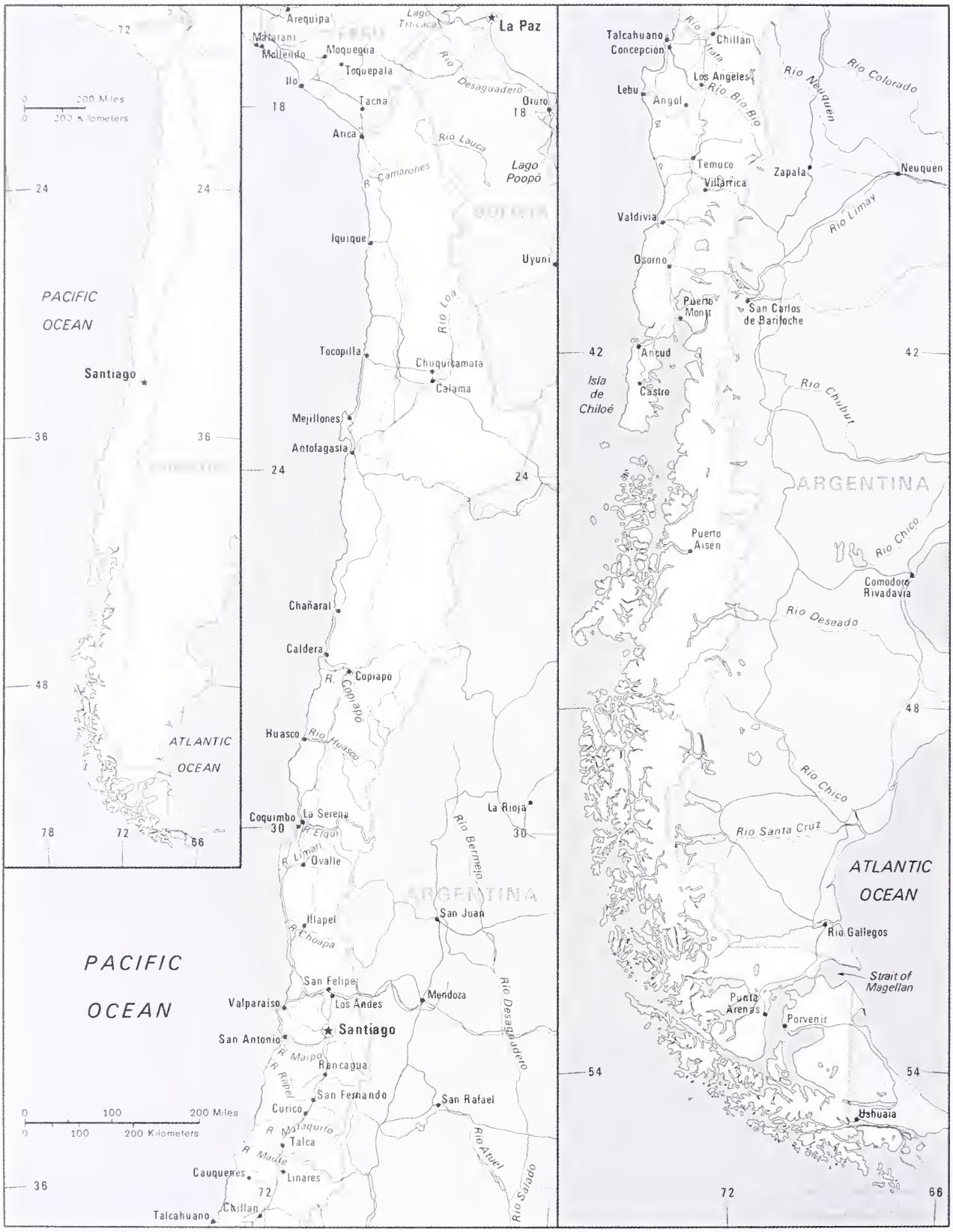
Chile has one of the largest fishing fleets in Latin America, exceeded only by the massive Peruvian fleet of small seiners. Chilean artisanal fishermen deployed nearly 13,000 vessels of various sizes in 1996. Over 200 companies and individuals deployed about 525 commercial vessels, about 70 percent of the actual number of vessels registered (appendix A1a). The commercial vessels land the great bulk of the country's catch, about 85 percent of the total. The active commercial fleet has a combined carrying capacity of 195,000 cubic meters and totals nearly 170,000 GRT (appendix A1b).[2] The number of commercial vessels has declined significantly in recent years, while the number of artisanal vessels has increased (appendix A1a and photo 1). Despite the decreased number of commercial vessels, the potential fishing power of the fleet has not declined (appendix A1b). Many of the newer vessels being added to the fleet are larger than the vessels which they have replaced and, as a result, the fleet's 1996 capacity was at record levels (appendix A1b). Chilean companies have reported substantial increases in the number of large vessels deployed (photo 2). As recently as 1987, Chile did not deploy fishing vessels with carrying capacities over 1,100 tons. Several such vessels have since been deployed, especially in 1995 and 1996 and about 45 were operating in 1996.[3] Most of these larger vessels have been deployed in the expanding jack mackerel fishery which requires larger vessels for offshore operations.

The commercial fishing fleet is dominated by the country's pelagic sector. Chilean companies reported a fleet of 385 purse seiners in 1996 (appendix A1a).[4] These seiners are deployed for small pelagic species (anchovy, sardines, and jack mackerel) in coastal waters, mostly in Regions I and VIII (photo 3).[5] Most of the vessels do

Photo 2.--Many Chilean companies have replaced small seiners with large new vessels or have enlarged existing vessels. Dennis Weidner.

Photo 3.--Vessels like this small seiner ("bolichero") are rapidly being replaced by smaller, more modern vessels. Dennis Weidner

Photo 4.--Many companies have modernized their seiner fleet in recent years, greatly improving the quality of fish landed. Dennis Weidner



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Scale 1:10,500,000; inset 1:30,000,000
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Railroad
Road

Figure 1.--Map of Chile.

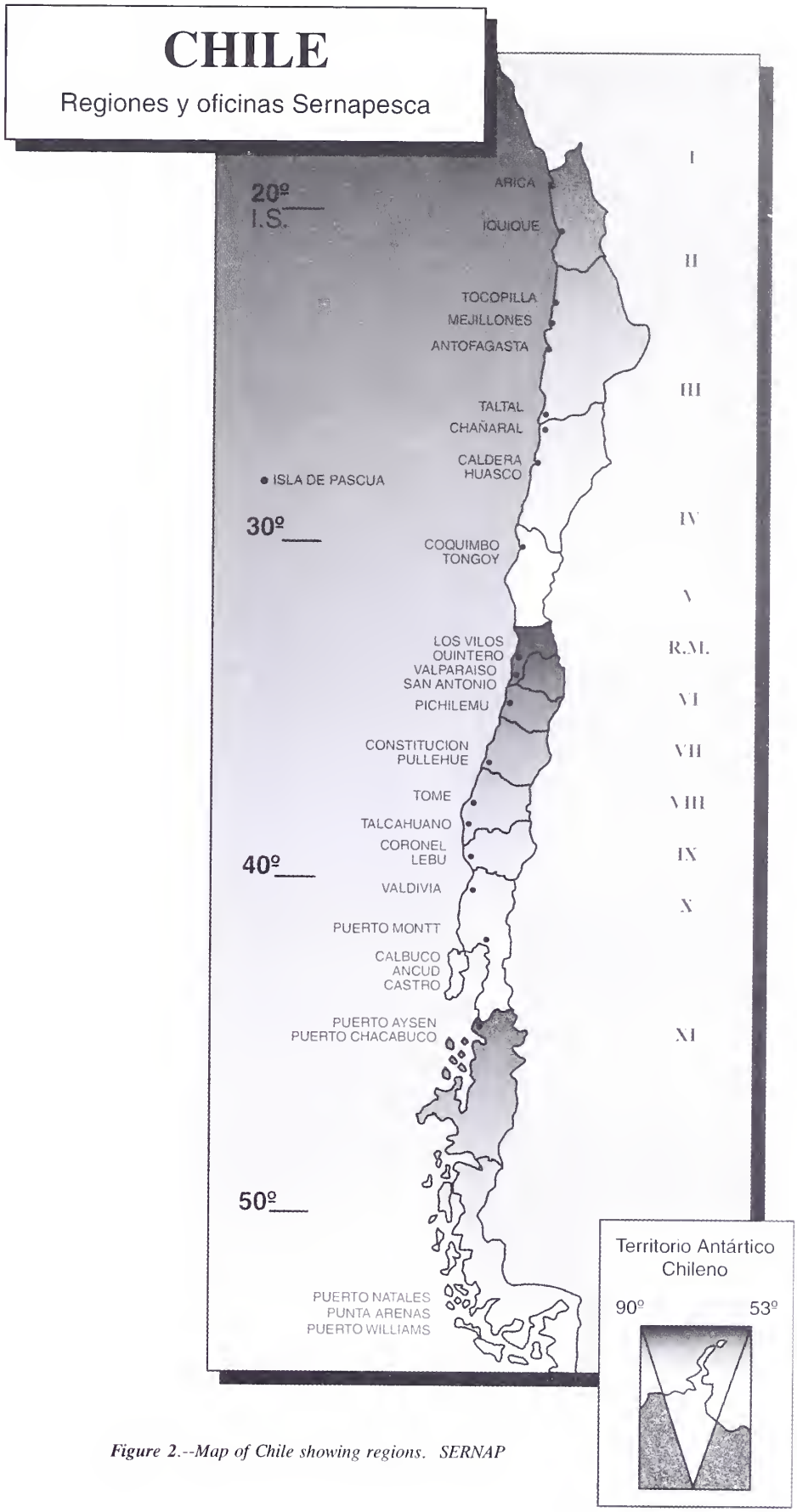

Figure 2.--Map of Chile showing regions. SERNAP

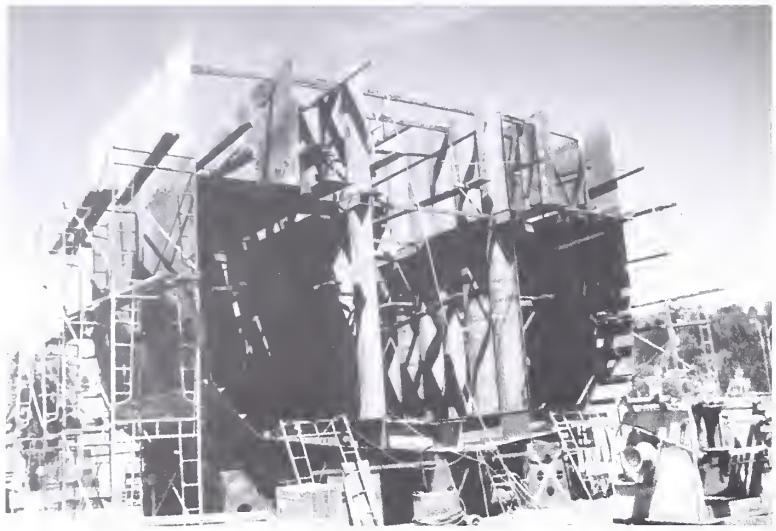

Photo 5 --Chile is expanding the capacity of its commercial fleet with some of the largest fishing vessels ever deployed in Latin America. Dennis Weidner

not have refrigerated holds which in addition to their small size restricts their range--preventing fishing operations on offshore grounds. While anchovy and sardines occur in coastal waters, jack mackerel occur in both inshore and offshore waters. Offshore jack mackerel operations, however, require longer voyages and deeper sets, beyond the capabilities of the small coastal seiners which make up much of the fleet. Chilean companies have acquired larger seiners in recent years and some of the seiners now have insulated holds to enable the fishermen to land their catch in good condition (photo 4).[6] Industry sources report that the common medium-sized seiners (averaging about 650 cubic meters) are rapidly being replaced by large seiners (850-1,600 cubic meters). The number of large seiners is believed to have doubled between 1991 and 1997.[7] Some of the larger seiners are newly constructed vessels while others are older vessels which have been enlarged (photo 5). The U.S. Embassy estimates that 79 new seiners totaling over 45,000 cubic meters were added in 1993 alone. The total hold capacity of the fleet increased an incredible 50 percent between 1990 and 1993.[8] Chilean companies in the early 1990s rushed to add new vessels before the end of September 1993 when the pelagic fleet was frozen in size. The Government will now only allow replacement vessels in developed fisheries to be added to the fleet.[9] These new, larger vessels are capable of increasingly long voyages enabling the fishermen to reach new previously unfished offshore grounds. Despite the expansion of larger vessels in recent years, the average size of the Chilean vessels is still less than the Argentine fleet which is composed primarily of trawlers.[10]

B. Catch

Chile regularly reports one of the largest fishery catches in Latin America. The 1994 catch was a record 7.8 million metric tons (t), a 30 percent increase over the 6.0 million t reported in 1993 (Latin America, appendix C1). Good catches were reported in 1995 and 1996, although down from the 1994 record. The 1996 catch was about 7.0 million t (appendices C1a-b). A developing 1997 El Niño is causing further catch declines. Some specialists believe it may the most powerful event affecting the fishing industry since the massive 1972 El Niño.[11] The fisheries catch may be even more significantly impacted in 1998.[12] An El Niño event not only impairs recruitment, but it makes anchovy and other species, especially pelagics, unusually vulnerable to the fishery within compact, easily accessible inshore areas. Fishing in 1997 could thus adversely affect recruitment for 1998.

Trends: Chile and Peru are the two major fishing country's in Latin America and their fishery catches have been comparable in recent years. The Peruvian 1994 catch was a massive 11.6 million t, the largest in over 25 years, far exceeding the more stable Chilean catch (appendix E1a). The Servicio Nacional de Pesca

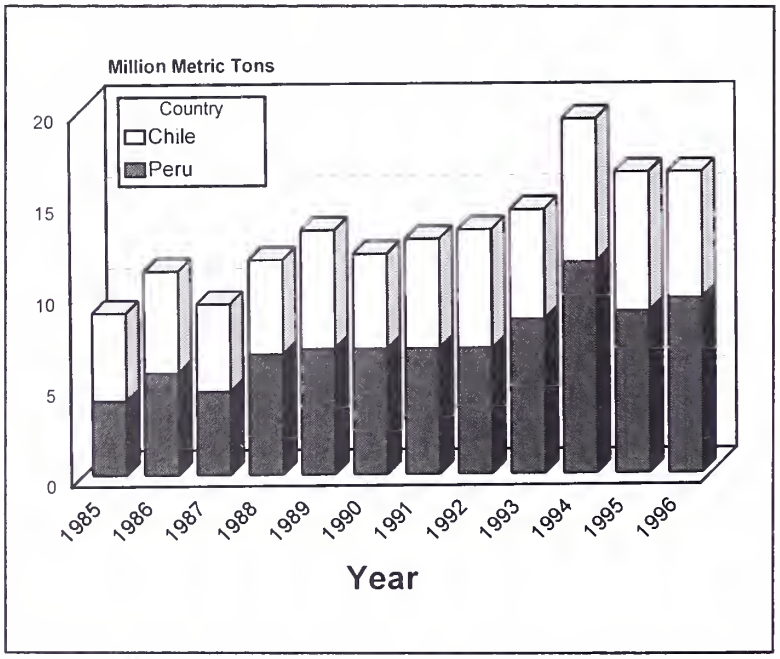

Figure 3 --Chile and Peru have been reporting near record catches in recent years.

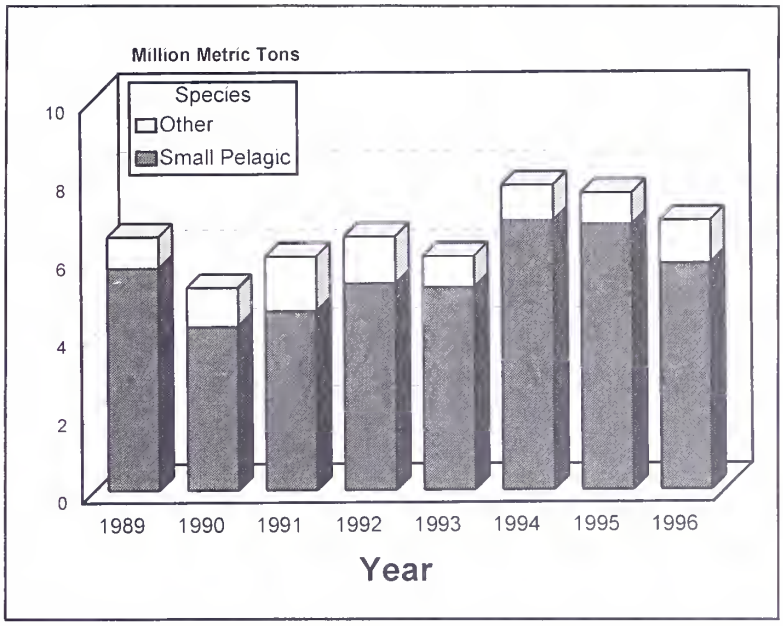

Figure 4.--The great bulk of the Chilean catch is still small pelagics (especially jack mackerel) which is primarily reduced to fishmeal and oil.

(SERNAP) reported the 1995 Chilean catch was 7.9 million t, but adjusted for FAO statistical guidelines (which do not include seaweed) the catch would be about 7.6 million t (appendix E1b and figure 3).[13] The 1996 catch was relatively stable at 7.2 million t or 6.9 million t adjusted for FAO guidelines (appendices E1a-b and photo 6).[14] Chilean officials reported catch declines in early 1997. The catch in the first quarter of 1997 was 5 percent below the 1992-96 average and nearly 20 percent below 1996.[15] Observers report that the warming water temperatures since March 1997 were adversely affecting catches, especially jack mackerel catches.[16] Chilean projections suggest that the catch may decline significantly to only about 5-6 million t for all of 1997.[17]

Grounds: The great bulk of the Chilean catch, over 60 percent, is taken along the south central coast (Regions V-IX). The remainder is divided among the northern (Regions I-II), north-central (Regions III-IV), and southern coast (Regions X-XII).[18]

Species: The Chilean catch, while large, focuses on a relatively small number of species. Industry sources report that the 13 largest fisheries account for 87 percent of the catch.[19] Despite this focus on only a few species, Chile waters contain a wide diversity of species suitable for commercial utilization.[20]

Reduction species: Most of the catch is composed of small pelagic species, primarily jack mackerel, anchovy, and sardines (figure 4). Chile conducts one of the world's largest fisheries for these species. The massive Chilean catch is largely reduced to fishmeal and oil (figure 110 and photo 7). Smaller quantities are canned. Usually more than 80 percent of the Chilean finfish catch is composed of these relatively low-value small pelagic species, but the total in some years has approached 90 percent (appendix E1b). The 1995 pelagic catch was, for example, nearly 90 percent of Chile's total finfish catch. The pelagic catch in 1996 was lower because of the declining small pelagic catch, but still nearly 85 percent (appendix E1b).

Edible species: Chile also reports a substantial catch of a variety of other, more valuable edible species. Industry and Government officials in the 1980s were hopeful that fisheries for these species could help diversify the industry beyond its focus on fishmeal reduction. The catch of edible species, however, peaked at 1.4 million t in 1991 (appendix E1b). The species taken included swordfish, hakes, several other desirable groundfish, shrimp, langostino, clams, scallops, and other mollusks, and a large variety of other species (photo 8). The species were targeted by both artisanal and commercial fishermen and expanding fishing effort appears to have resulted in the overfishing of many stocks (photo 9). The catch of these species, as a result, declined to only 0.8 million t in 1995, or by over 40 percent. The catch recovered somewhat to 1.1 million t in 1996 (appendix E1b). The catch decline in several high-value species has been

Photo 6.--Artisanal fishermen land a small proportion of the catch, but most of the more valuable species. Dennis Weidner

Photo 7.--Chile is one of the world's leading producers and exporters of fishmeal. Most of the Chilean production in recent years has been jack mackerel. Dennis Weidner

Photo 8.--A wide range of finfish and shellfish can be found in Chilean markets. Dennis Weidner

Photo 9.--Many especially valuable species, like these sea urchins, have been overfished and the fishery is now strictly regulated. Dennis Weidner

Photo 10.--Chile during the past few years, has developed the world's second largest salmon culture industry. The only important one in the southern hemisphere. Dennis Weidner

partially compensated for by the rapidly expanding cultured harvests of salmon and trout--currently the second most important salmonid culture industry in the world (photo 10). The Subsecretaría de Pesca (SSP) has initiated the most sophisticated fisheries management effort in Latin America which is designed to more efficiently utilize fishery resources.[21] New comprehensive fisheries legislation passed in 1991 provided the basis for innovative new management approaches. Officials are hopeful that catches can be returned to more optimal levels.[22] Some Chilean companies have, however, complained of the lack of "transparency" in the regulatory process. The new Subsecretario de Pesca, Juan Manuel Cruz, has recognized these complaints and reportedly determined that the industry matters handled by SSP should be dealt with more transparently in the future.[23] Even developed countries with sophisticated management programs, however, often find it politically difficult, because of the often serious impact on the fishermen involved, to restrict fishing effort sufficiently to allow stocks to recover. Thus the recovery of several depleted Chilean stocks may be an extended process. SSP has already reported some successes, such as the langostino fishery.[24]

C. Companies

Chilean fishing companies reported considerable success during the 1980s. The profits achieved have enabled several companies to make major investments in modernizing vessels and processing plants. One source estimates that investments in the fishing industry reached $100 million in 1988, although new investment apparently slowed during 1989 and 1990.[25] A more recent analysis indicates that investments may have totaled $400 million during 1993 and 1994 (photo 11). One source estimated that fishing companies were likely to invest about $600 million in the fishing industry during the mid-1990s (1993-98).[26] This capital has come from domestic investors. The SSP estimates foreign investment during the 1990s at only a few thousand dollars.[27]

Chile's fishing companies handling meal and canned product during the 1990s have had several highly profitable years, in part due to the excellent catches. Profitability though is affected by a variety of factors besides catches, such as international prices. Some companies reported disappointing results in 1993, for example, when fishmeal prices fell.[28] Several of the large cooperations have entered the salmon culture industry which in most cases has proven extremely profitable during the 1990s. A number of smaller companies have begun to export high-quality fresh product during the 1990s, although some have been impaired by resource problems as catches of several increasingly heavily fished resources have declined. Many companies, especially the larger corporations concentrating on fishmeal, are especially concerned with the developing 1997-98 El Niño which has already adversely affected catches. Projections of a major El Niño event has significant potential consequences for

Photo 11 --Chilean companies have made very substantial investments in modernizing the fishing fleet and processing plants. Dennis Weidner

1997-98 results at many companies.

Chilean fishing companies are a major source of employment. Full-time jobs in the sector have increased from only 13,000 in 1980 to over 69,000 in 1993. About half of the jobs are in fisheries for edible species and the other half fairly evenly divided between the reduction fishery and aquaculture. The increases in aquaculture employment has been particularly notable since 1985.[29] Chilean companies have reported steady increases in employee productivity. The output of edible products per employee has more than doubled since 1988 and the output of fishmeal has actually tripled.[30]

D. Commodities

The Chilean fishing industry produces a wide variety of fishery products.

Edible products: Substantial investments has been made to expand the fleet deployed for edible species. Companies have been acquiring modern trawlers and longliners which has enabled them to extend their range of operations to the lightly populated southern coast and to improve handling procedures (photo 12).[31] Much of the catch of edible species is taken by artisanal fishermen who have also greatly expanded their fleet (photo 13). Chilean companies have been steadily increasing the quantity of processed product, from only 43,000 t in 1980 to a record approaching 275,000 t in 1995 (appendix G1b). Another large increase was reported in 1996 when 310,000 t of processed seafood was produced. Much of the increase, however, is cultured salmon. This record has only been set because of the phenomenal development of a salmon and trout culture industry in Chile--currently the world's second largest salmonid culture operation. Landings in several capture fisheries have actually declined and many fishermen are reporting financial difficulties. Artisanal fishermen targeting swordfish experienced such serious problems during 1995-96, for example, that many withdrew from the fishery in 1996 and artisanal catches plummeted (appendix E2f and figure 5). The management of these fisheries have proven very difficult. Hard pressed artisanal and commercial fishermen have in many cases strongly opposed limitations on their operations and, as in other countries, the resulting management plans restricting effort, have proven highly controversial.

Fresh and frozen: The production of fresh and frozen finfish products in 1995 was a record 37,000 t of fresh product and 160,000 t of frozen product (appendix G1b and photo 14). Companies processing fresh product reported a massive increase in 1996 to nearly 75,000 t, double the record amount produced in 1995. Companies are experimenting with new products like surimi (photo 15). These totals, however, obscure the actual situation for capture fisheries and associated processing companies in Chile. Capture fishermen once supplied most of the fresh product, primarily swordfish, southern hake, and a variety of other groundfish (appendix G1c and figure 6). Declines in

Photo 12.--Modern trawlers and longliners have been acquired by Chilean companies, primarily to target groundfish. Dennis Weidner

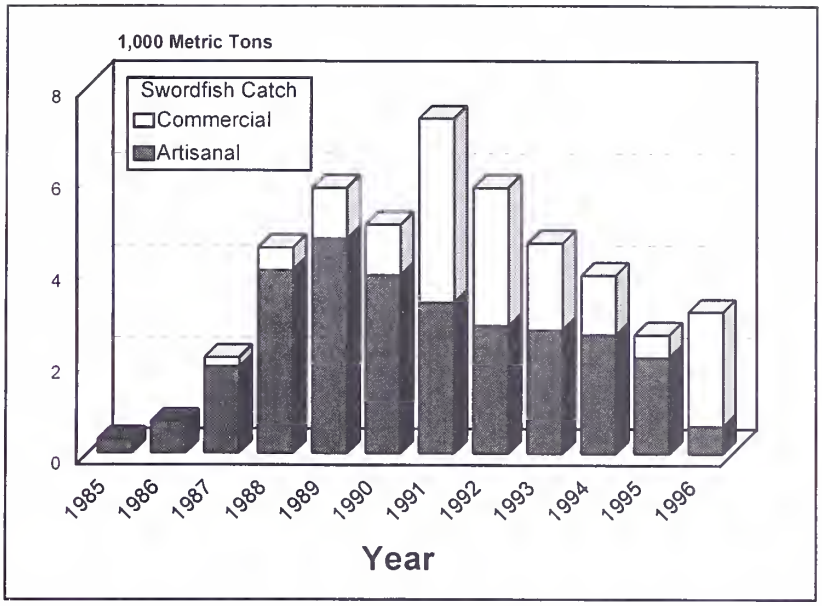

Figure 5.--The artisanal swordfish catch has fallen steadily since 1991 reaching especially low levels in 1996.

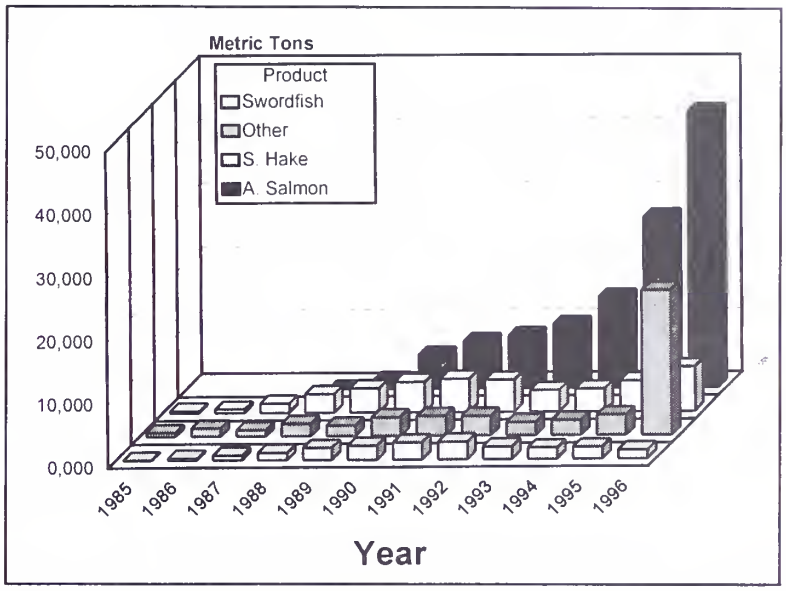

Figure 6.--The fresh product supplied by fishermen has declined and the principal product is now cultured salmon. Fishermen did, however, increased landings of fresh groundfish in 1996.

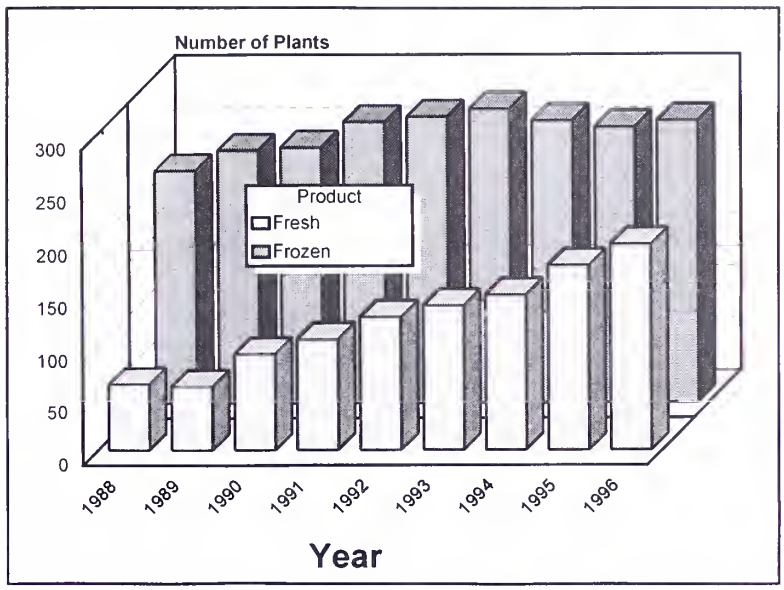

Figure 7.--The number of Chilean plants processing fresh product is growing rapidly.

Photo 13 --Chile's artisanal fishing fleet has steadily expanded in recent years. Dennis Weidner

several of these important capture fisheries have meant that the fishermen can no longer supply product in such large quantities. The great bulk of the fresh product processed in Chile is now cultured salmon and trout (appendix G1b). A similar, but not as drastic situation, has occurred in the production of frozen fish. Many processing plants have successfully shifted to processing raw material from an expanding number of increasingly sophisticated marine farms. SERNAP reports in 1996 that a record number of plants producing fresh product (196). The number of freezing plants (268) is only slightly below the record (appendix G1d and figure 7). Twenty new plants processing fresh product opened in 1996. While processing plants and exporters are reporting record earnings, many fishermen cannot report similar favorable results. Many have been adversely affected by the declining yields in several important capture fisheries (langostino, Patagonian toothfish, and others). Frozen shipments were the single most-important fishery export commodity in 1995, approaching $660 million (appendix J1b), but declined somewhat in 1996. While fresh products were only the third leading sector with 1995 shipments of nearly $220 million, fresh production was the most rapidly expanding product form in 1996. Chilean companies increased fresh shipments nearly 20 percent in 1996 to about $260 million.

Canned: The principal edible processing form in Chile has traditionally been canning (appendix G1b and photo 16). Fish canning was the first commercial fishing activity to develop in Chile and canned production was the principal form of processing until the late 1980s. The quantity of frozen product did not exceed that of canned product until 1988. Canneries produced nearly 74,000 t of canned fish in 1995, about 10 percent below the record 81,000 t produced in 1994 (appendix G1b). The quantity of fresh product exceeded that of canned product in 1996. The quantity of canned product fell again in 1996, but was still a substantial 68,000 tons. Exports of canned products are important to many established companies, but the value of exports has declined to fourth place among key export commodities. Canned exports earned $119 million in 1995, but declined to only $113 million in 1996 (appendix J1b). Companies are attempting to improve the quality and diversity of products. Chilean canned products have traditionally been low-priced packs, but companies are now producing a variety of different packs aimed at more affluent consumers.[32]

Meal and oil: Chile's principal fishery commodity has since the 1960s been fishmeal and oil. Chile used 6.7 million t of the 7.7 million landings in 1995 for reduction to fishmeal, or about 87 percent (appendix G1a). About the same proportion was used in 1996, although there has been a gradual decline in the proportion of the catch devoted to reduction. About 95 percent was being reduced in the mid-1980s (appendix G1a). Most of the meal produced is exported, but in recent years there have been major increases in the quantities consumed domestically. Domestic fishmeal consumption has increased from only 80,000 t in 1990 to nearly 385,000 t in 1994, in part because of expanded demand for livestock and fish feeds.[33] Chile has one of the world's largest and most modern fishmeal industries (photo 17). Fishing companies have reported profitable operations and, as a result, have acquired larger, more modern seiners to target offshore jack mackerel stocks.[34] This has enabled the companies to steadily increase jack mackerel catches from 1.2 million t in 1986 to record catches of 4.0 million t in 1994 and 4.4 in 1995. The 1996 catch declined somewhat to 3.9 million t (appendix E1b). The Chileans in 1991 replaced the declining Soviet effort on offshore jack mackerel.[35] The large modern seiners added to the fleet provide Chile a substantial fishing potential.[36] These large seiners also allowed companies to improve the quality of fish delivered to the reduction plants, permitting production of more profitable, high-quality fishmeal for both Chile's expanding aquaculture

Photo 14.--Chilean processors have rapidly increased their production of high-quality fresh and frozen fish in recent years. Dennis Weidner

Photo 15.--Companies are assessing the possibility of producing new products like surimi. This surimi was made from hake, but other companies are working with jack mackerel. Dennis Weidner

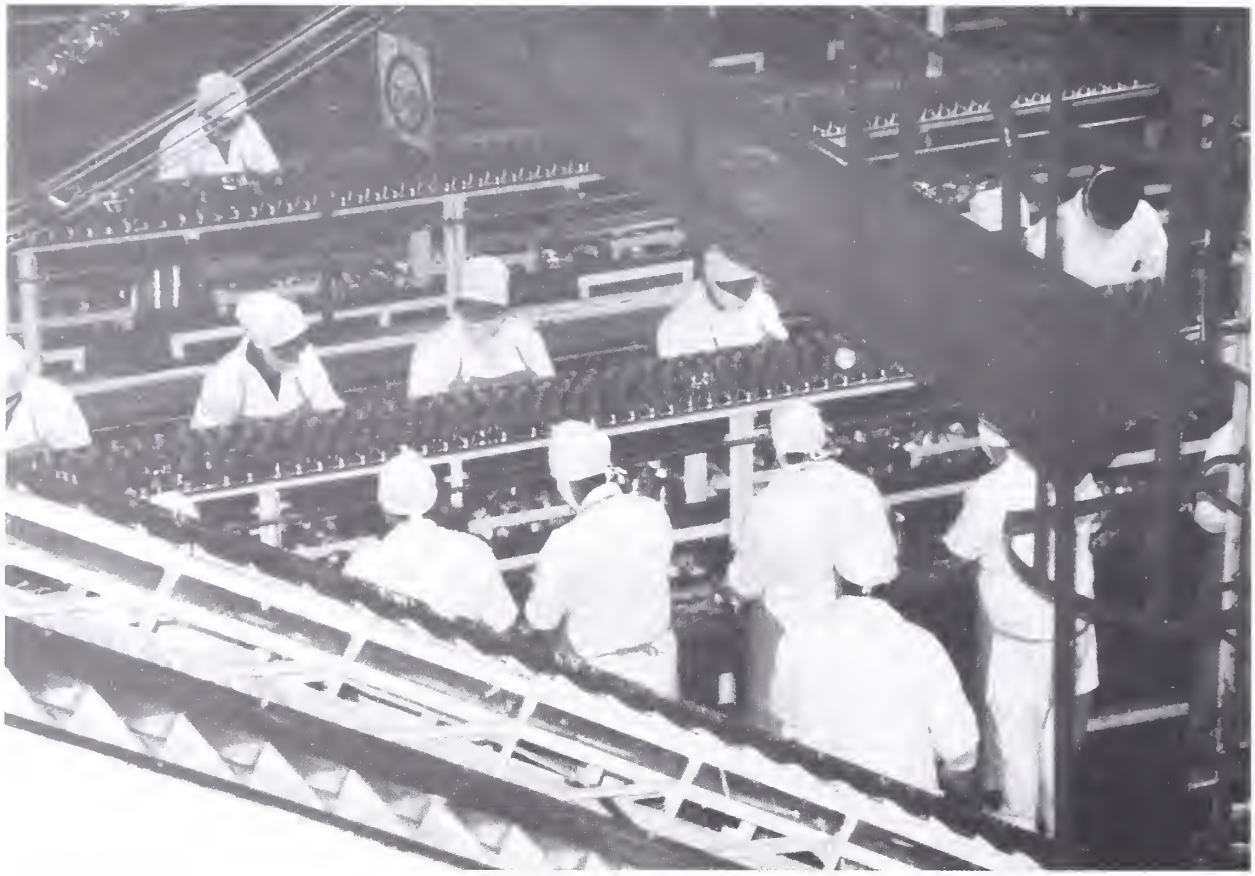

Photo 16--Canning continues to be important to many companies. The primary product is jack mackerel. Dennis Weidner

industry and for export (photo 18). Export shipments of meal totaled over $630 million in 1995, or over one-third of all Chile's fishery shipments (appendix J1b and figure 8). This places meal shipments slightly below the value of frozen products. Shipments were comparable in 1996, although the value of frozen fish and meal declined slightly.

E. Exports

Chile's growing fishing industry has developed into one of the country's leading export sectors. Government officials and many companies hoped to diversify Chile's fishing industry which since the 1960s has centered primarily on the fishmeal reduction industry.[37] Seafood is popular in Chile, the small population means, however, that Chilean companies must seek export markets (photo 19). Government officials encouraged companies to expand markets by identifying new buyers (photo 20).[38] The Government in 1985 offered export incentives (draw backs) to companies exporting non traditional products. Swordfish products initially qualified for those incentives. Fishing companies have reported impressive increases in export shipments during the 1980s and 1990s. Exporters

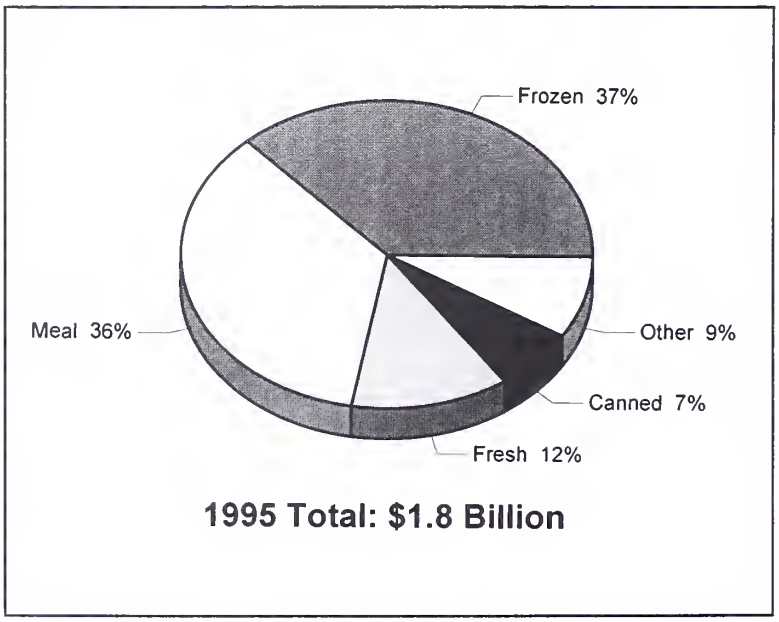

Figure 8--Fishmeal exports continue to be important, but no longer dominate Chile's fishing industry.

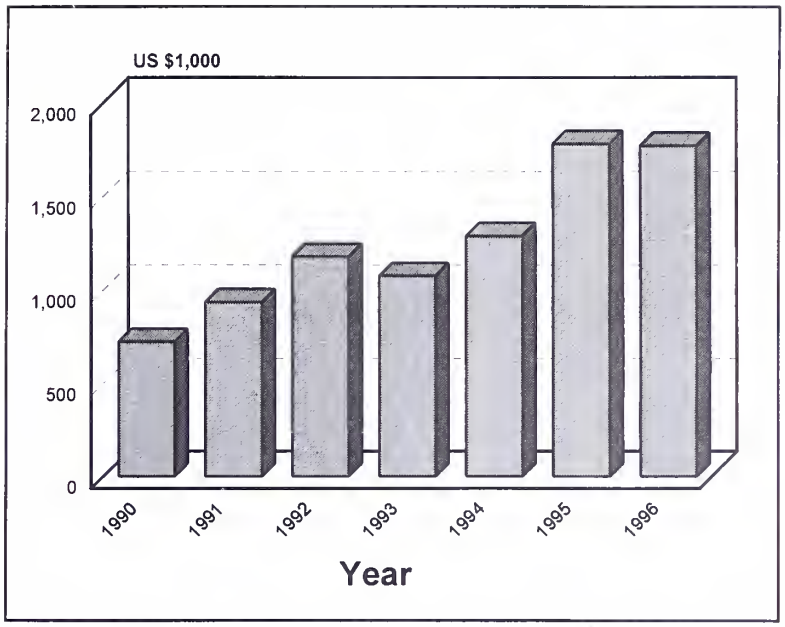

Figure 9.--Chilean exporters have reported major increases during the 1990s

increased shipments from only $0.3 billion in 1980 to nearly $1.3 billion in 1994 (Latin America, appendix E1, and photo 21). Chilean exporters increased shipments during 1995 to an astounding $1.8 billion, although 1996 shipments declined slightly. Increases during the 1990s (averaging over 20 percent annually) are remarkable for a maturing industry (appendix J1a and figure 9A). Exports in 1997 may decline somewhat. Many companies in early 1997 were reporting a substantial decline in export shipments, primarily due to catch reversals and the resulting shortage of raw material.[39]

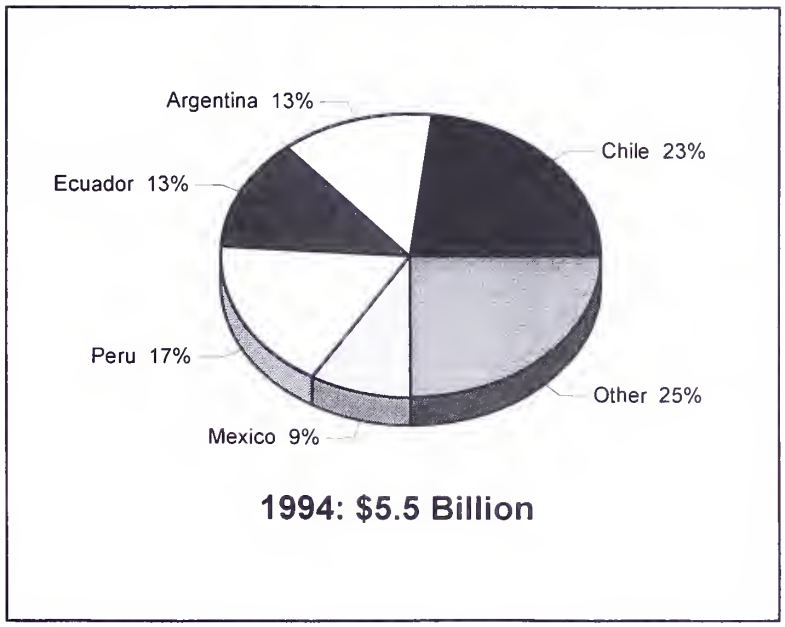

Figure 9A.--Fishmeal exports continue to be important, but no longer dominate Chile's fishing industry.

Chile is now the most important exporter of fishery products in Latin America and provides nearly 25 percent of the region's total fishery exports (Latin America, appendix E1 and figure 9A). While export shipments in the 1970s and 80s were mostly fishmeal and oil, by 1995 the reduction industry only accounted for about one-third of fishery export earnings (appendix J1b). The actual value of meal exports increased during this period, but shipments of edible products have increased at an even more rapid pace. Chile's principal market is Asia (especially Japan and Taiwan) which accounted for about half the value of total export shipments.[40] Japan is the major market for Chilean shipments of frozen fish while most fresh fish exports are marketed in the United States.[41]

Photo 17.--Chilean companies in recent years have made major investments in the fishmeal industry which is now one of the world's most efficient. Dennis Weidner

Photo 18.--Chilean companies are expanding production of high quality fishmeal which can be used to produce fish feed for the growing salmon culture industry. Dennis Weidner

Photo 19.--A wide range of seafood is available to Chilean consumers. Chilean companies must turn to foreign countries, however, to market the country's huge harvest. Dennis Weidner

Photo 20.--Chilean companies are active in many international fishery trade shows. Dennis Weidner

Photo 21.--Chilean exports of seafood have replaced fishmeal as the country's primary fishery export. Dennis Weidner

II. Species

Relatively little biological research is available on swordfish off Chile and no fisheries independent stock assessment work has been conducted. Almost all of the available information is data collected from the fishery. Some of the most comprehensive existing data sets have been compiled by foreign fishermen. Little data was collected from the Chilean artisanal harpoon fishery, despite the long time period during which it was conducted. Interest in swordfish increased as the fishery grew in importance during the late 1980s. Researchers in the early 1990s began to collect detailed statistics on the species. The SSP as part of its desire to formulate an effective management program, has designated swordfish as a research priority. The Instituto de Fomento Pesquero (IFOP) is coordinating the assessment. (See "Research.") Chile is one of the few Latin American countries conducting significant research on swordfish.[42]

The Chilean assessment of swordfish is still in its initial stage. Many of the data sets cover only a few years. As a result, assessments based on this initial data are still tentative and highly speculative. The following discussion of the preliminary data collected is an attempt by the authors to review the existing data collected by Chilean researchers and correlate it with available foreign data. It should be read with caution and used as a preliminary summary of the ongoing research program. The observations offered by the authors are intended only as an initial overview of the growing body of Chilean and foreign data.

A. Stock structure

The stock structure of Pacific swordfish is not well understood. The subject is, however, being addressed by researchers in several countries who are beginning to formulate some tentative hypothesis. There are clearly several areas in the Pacific where swordfish are most abundant. Fisheries data shows clusters of high yields and catches which may reflect actual abundance, although such fishery-dependent data has to be used with some caution. Whether those geographic concentrations or clusters represent separate stocks is still unclear, but in many fisheries distinct, separated clusters are strong evidence of stock structure. Such clustering while important evidence, is less definitive when assessing the stock structure of highly migratory species like swordfish. This is especially true when the primary source of data is the Japanese and other Asian longline fisheries in which swordfish was not the principal target species.

Researchers have formulated a variety of hypothesis to explain swordfish stock structure in the Pacific. Skillman suggests that there is **one** single Pacific-wide stock.[43] The United States National Marine Fisheries Service (NMFS) researchers Bartoo and Coan have considered the possibility that there may be **one** single Pacific-wide stock, but discuss **three areas** of high abundance (northwest, northeast, and southwest).[44] Japanese researchers believe that there may be a single genetic stock with several sub-populations which may have different recruitment patterns.[45] Other researchers have also discussed various possibilities including **three stocks**.[46] Mexican researcher Sosa-Nishizaki has suggested the possible existence of **four** fishery units.[47] NMFS researcher Sakagawa has reported **five** areas with high abundance of swordfish which are related to frontal zones.[48] Recent work by Inter-American Tropical Tuna Commission (IATTC) researchers Hinton and Deriso reports findings supporting a stock centered in the southeastern Pacific and suggests that there may be other stocks centered in different areas such as the northeastern Pacific.[49]

The observable Pacific clusters of high swordfish yields persist over time in the same general areas. These clusters exhibit relative long-term stability in the eastern Pacific, although the precise location is highly seasonal at the southern, temperate latitudes off Chile (figures 10 and 11). Some variation could also be due to oceanographic events or long term climatic trends. Foreign researchers have noted significant shifts in other areas as a result of long-term climatic cycles.[50] Chilean researchers have begun to assess possible linkages in the southeastern Pacific between climatic variables and swordfish populations and abundance.[51]

Several factors suggest that Chilean swordfish may belong to a southeastern Pacific stock separate, but not isolated, from the wider pan-Pacific population. The stock structure of swordfish occurring off Chile in the southeastern Pacific is not, however, known with any certainty. Tagging data, the most definitive evidence does not exist to substantiate migratory movement which would provide possible insights into stock structure. Some less definitive evidence, however, does offer some indication that the swordfish along the Pacific coast of South America may be a separate southeastern Pacific stock as suggested by IATTC researchers. The theorized southeastern Pacific stock appears to have a distinct genetic pattern, different--but not completely isolated from a larger pan-Pacific stock. This and other accumulating, but not yet definitive

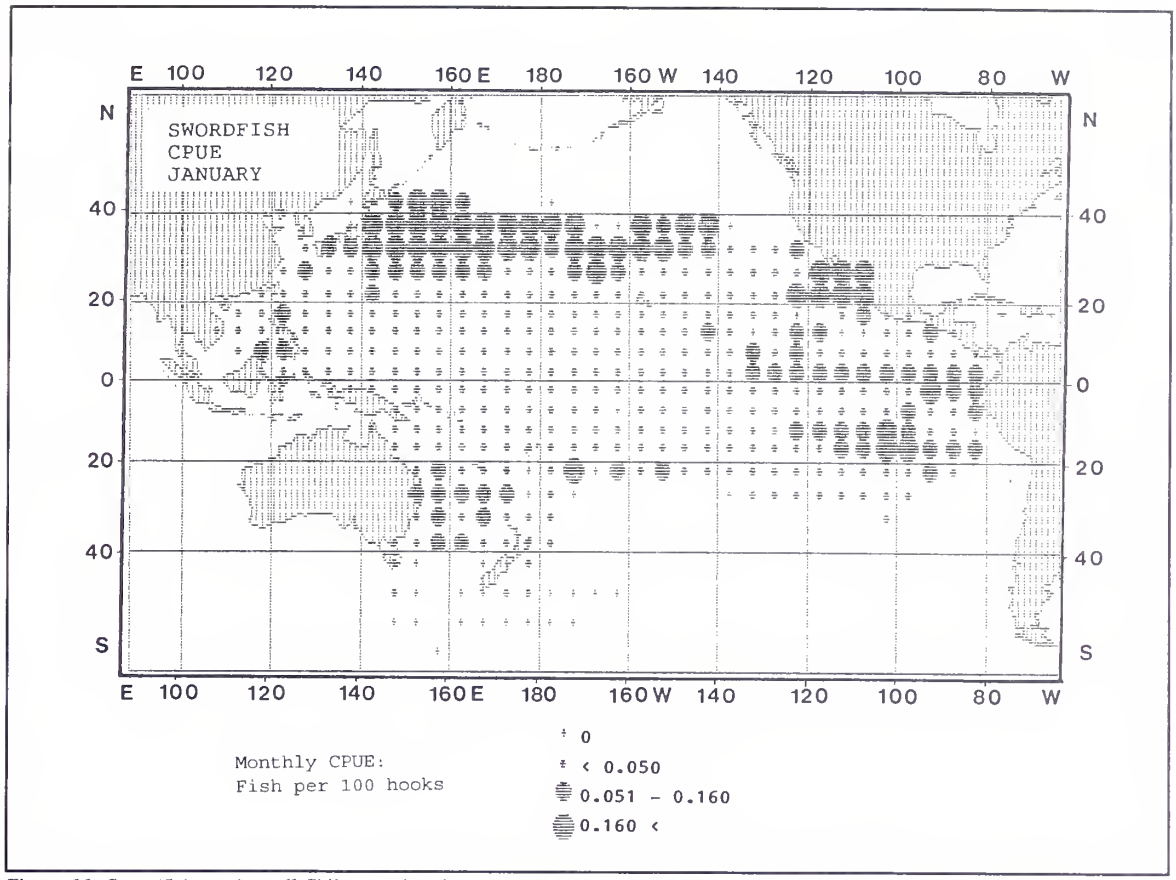

Figure 10. Swordfish catches off Chile are historically highly seasonal. No Japanese fishing is normally reported during January. Sosa and Shimizu.

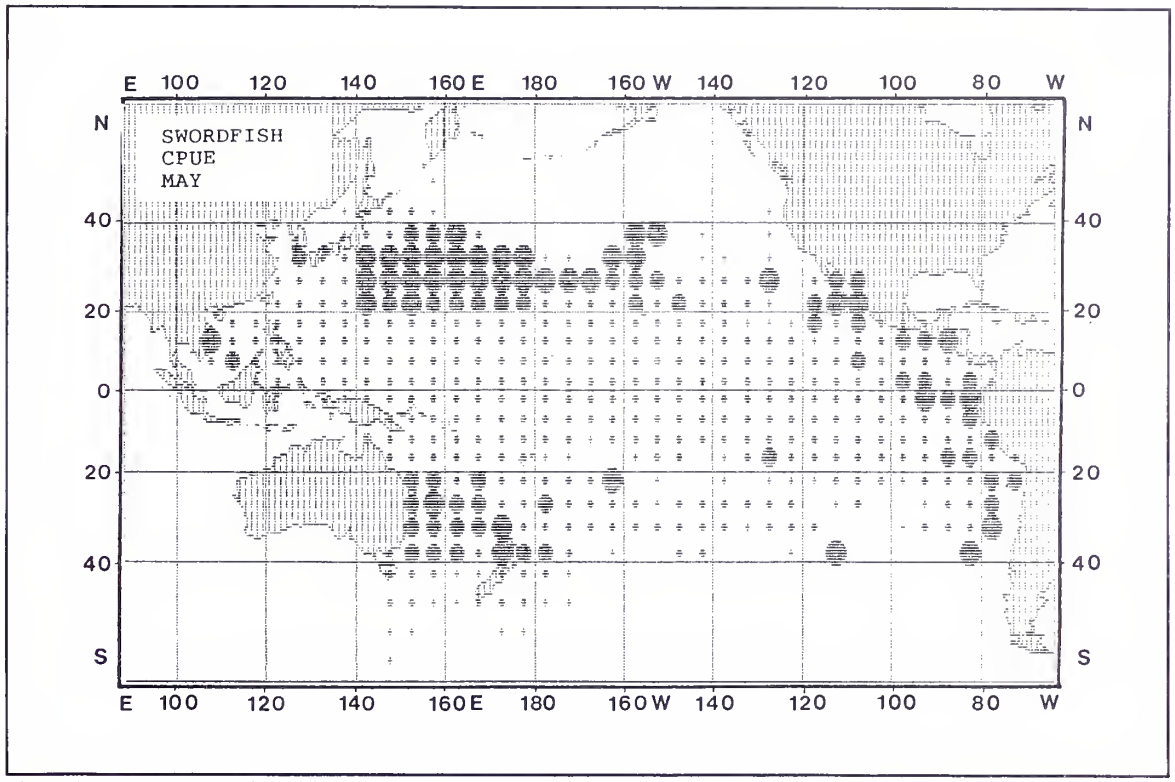

Figure 11.--The Japanese historical records suggest that they generally begin to take swordfish off Chile in May. Sosa and Shimizu.

evidence, suggests that the species in Chilean waters is part of a separate stock stretching from Colombia/Ecuador (5°N) south to central Chile (about 40°S). While not all of the available evidence leads to this conclusion, the preponderance of available data does suggest a separate southeastern stock as a strong working hypothesis.

Catch patterns: Geographic and seasonal catch patterns offer some insights into stock structure. A prominent cluster of high catches and yields is discernable in the southeastern Pacific. (See "Distribution".) This **geographic** clustering of catches suggests a possible separate, but not isolated southeastern Pacific stock. Such geographic catch clusters in many fisheries, especially relatively sedentary species, can be indicators of separate populations. Such a conclusion for highly migratory species like swordfish, however, is less definitive. This is especially true as much of the seasonal catch data available for oceanic areas is from foreign distant-water fisheries in which swordfish was not the target species.[52] The **seasonal** catch patterns provide some further evidence, but are somewhat ambiguous.

Geographic: Available data on current and historical fishing patterns provide some evidence of a separate, but not completely isolated, southeastern Pacific stock. Fishing patterns for most major fishing countries suggest that swordfish are taken widely in the Pacific, but there is a discernable area in the southeastern Pacific where swordfish catches are more important than in surrounding areas (Ecuador, figure 8).[53] The fishing pattern reported by the Latin American coastal countries, especially Chile, combined with the available Japanese and other foreign longline data in oceanic areas, form a distinct cluster in the southeastern Pacific suggesting a possible separate southeastern Pacific population.

Japan: Japanese longline fishing patterns during the 1990s show a distinct, but not isolated clustering of catches in the southeastern Pacific (figure 12).[54] Historic Japanese yield data for 1952-85 also show a similar clustering in the Pacific, however the southeastern Pacific cluster of high yields is less well defined than that exhibited by the catch data (figure 11).[55] The Japanese data shows especially well defined clusters at tropical latitudes. The latitudes off Chile, however, show widely varying results in different studies of foreign longline data. To some extent this is because Chilean enforcement of its 200-mile zone in recent years has reduced or prevented foreign fishing--although considerable Japanese and other Asian longline activity has been reported to the north in Peruvian costal waters where foreign vessels have obtained access under varying licensing/leasing arrangements.[56]

Chile: Data from the current Chilean fishery would make the cluster shown by Japanese longline data even more prominent and fill in some low catch/yield areas in coastal areas. With Chilean data, the southeastern Pacific cluster of high catches and yields is even more pronounced and stretches further south to coastal grounds off central Chile (figure 13).[57] The expansion west by commercial fishermen, especially in 1996 (appendix E2g and figure 14), suggest that the southeastern Pacific cluster

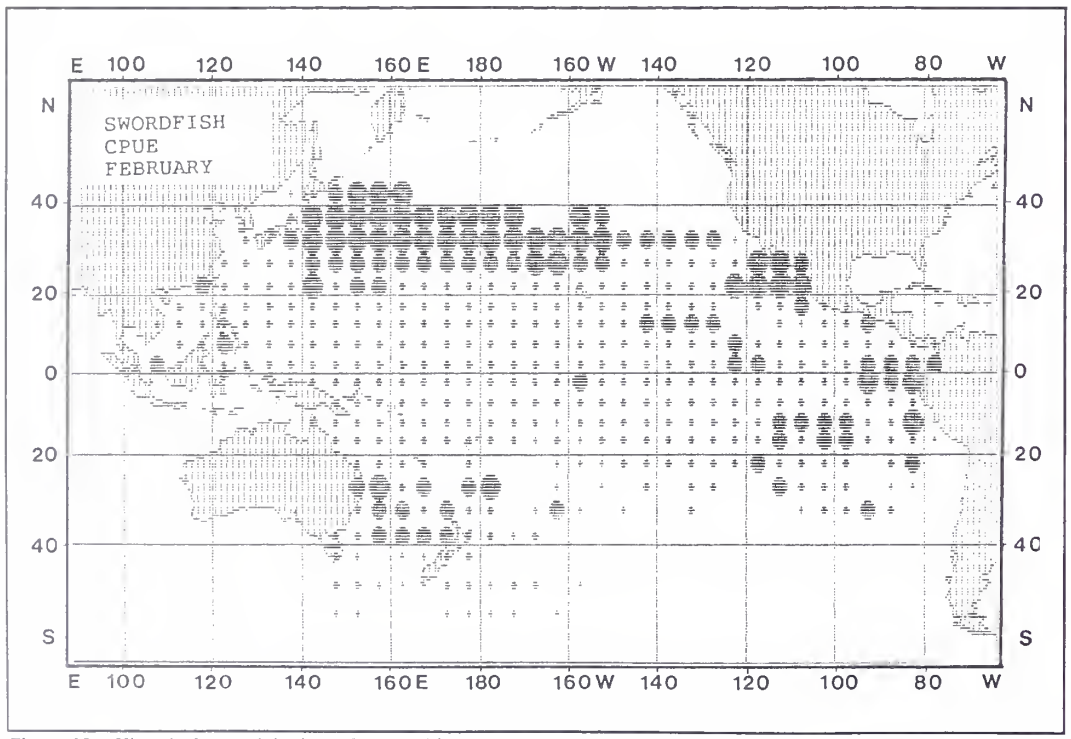

Figure 12.--Historic Japan yield data often provide a less clear cut southeastern Pacific cluster than their catch data. Sosa and Shimizu

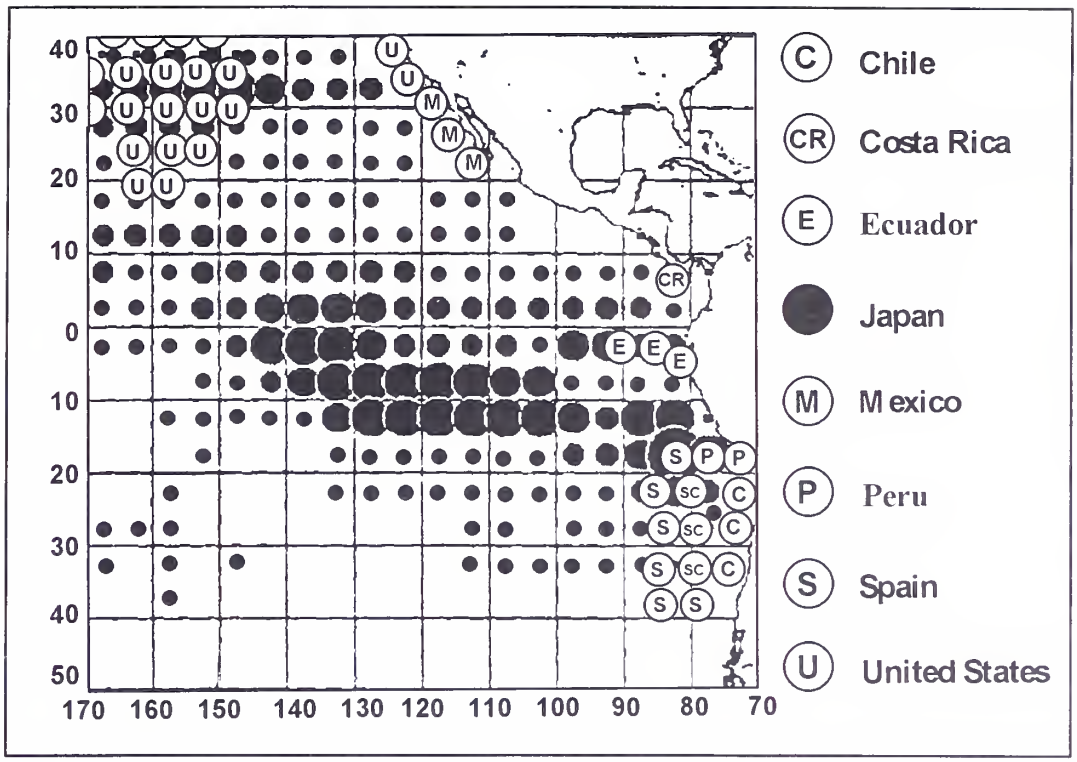

Figure 13.--Latin American and Spanish catch data expands the cluster of high catches in the southeastern Pacific reported by the Japanese.

the Japanese fishery in recent years is a multi-species fishery targeting primarily bigeye. Thus fluctuations in the swordfish catch may actually reflect changes in the fishing strategy for bigeye rather than actual swordfish abundance. Results from Chile (the other major southeastern Pacific swordfish fishery) also show a

may also extend a substantial distance offshore at latitudes off central Chile (figure 13). (See "Distribution".)

Ecuador/Peru: Other Latin American fisheries, discussed in the individual country chapters, add to the southeastern cluster described by Japanese and other foreign fishermen. Currently the Ecuadorean fishery is the more important, but historically Peruvian fishermen have landed very substantial quantities of swordfish in coastal waters, especially along the northern coast. This provides further evidence of a southeastern Pacific cluster and a possible distinct population.[58]

Spain: The southeastern Pacific cluster would be still further enhanced in oceanic areas at latitudes off Chile if Spanish fishermen were reporting their Pacific catches. While relatively little information is available, Spanish appear to be operating primarily off Chile and southern Peru at distances of up to 850 km from the coast.[59]

Annual fluctuations: There appears to be some similarity in catch fluctuations which would suggest a possible common stock. The lack of detailed catch data from most of the coastal countries, however, makes such a conclusion tenuous. The Japanese swordfish fishery in the southeastern Pacific (FAO area 87) peaked in 1992 at 1,027 t (appendix E5 and figure 15). The Japanese catch had since declined sharply to only 477 t in 1995. The authors stress, however, that significant decline. The Chileans like the Japanese have reported major catch declines in the 1990s. The Chilean fishery peaked at nearly 7,300 t in 1991 and declined to only 2,600 t in 1995 (appendix E2a1 and figure 91). This corresponds to the Japanese trends. Chilean catches increased somewhat in 1996, but this appears to be primarily because fishermen intensified operations on previously lightly fished offshore grounds (appendix E2g and figure 14). (See "Catch".) Ecuadorean catches in coastal waters have also been declining, although available data is limited and contradictory (Ecuador, appendix B2 series). Increased Ecuadorean catches reported in recent years appear to come from opening a new fishery in grounds west of the Galápagos.[60]

Seasonal fluctuations: Swordfish catches appear to show a very complex seasonal pattern within the southeastern Pacific. The Japanese and Chileans report a pattern at temperate latitudes which appears to suggest that as coastal catches decline (July-September), oceanic catches increase (October-December). The pattern reported by the Japanese and other foreign fishermen at tropical latitudes is more complicated and difficult to assess. Thus while there are some distinct seasonal patterns, especially in the southern area of the southeastern Pacific, there does not appear to be one clear overall pattern.[61] The fact that the seasonal pattern in tropical and temperate waters differs, does not necessarily suggest stock

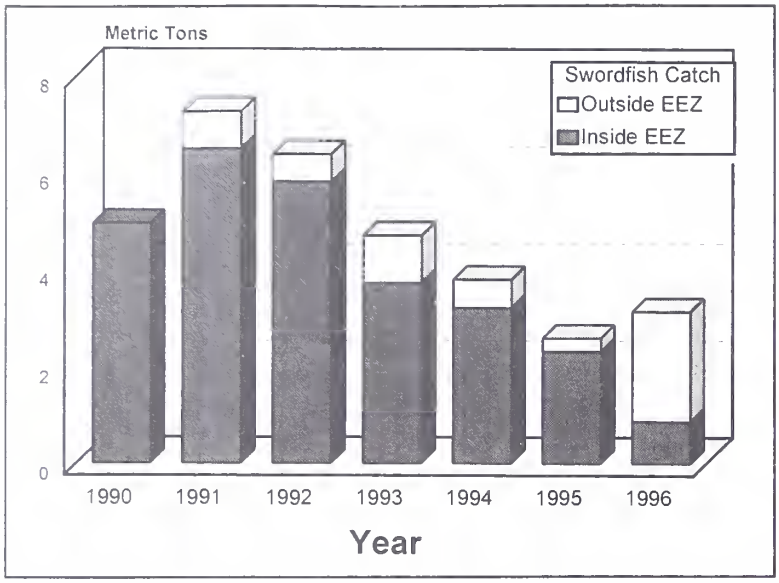

Figure 14.--Most of the Chilean catch in 1996 was for the first time taken beyond the country's 200-mile zone.

differentiation. There are a variety of seasonal patterns in the wider Pacific yet there is increasing evidence to suggest that fish taken in several different areas (Hawaii, Japan, Australia, and others) may all belong to the same stock.

Temperate waters: There is a distinct seasonal pattern for southeastern Pacific swordfish in temperate waters south of about 20°S. Such strong patterns are important evidence that the fish involved, at least in the southern portion of the southeastern cluster, belong to a common stock. The Chilean fishery is highly seasonal. There are annual fluctuations, but both the artisanal and commercial fishery report distinct seasonal patterns. (See "Seasonality".)

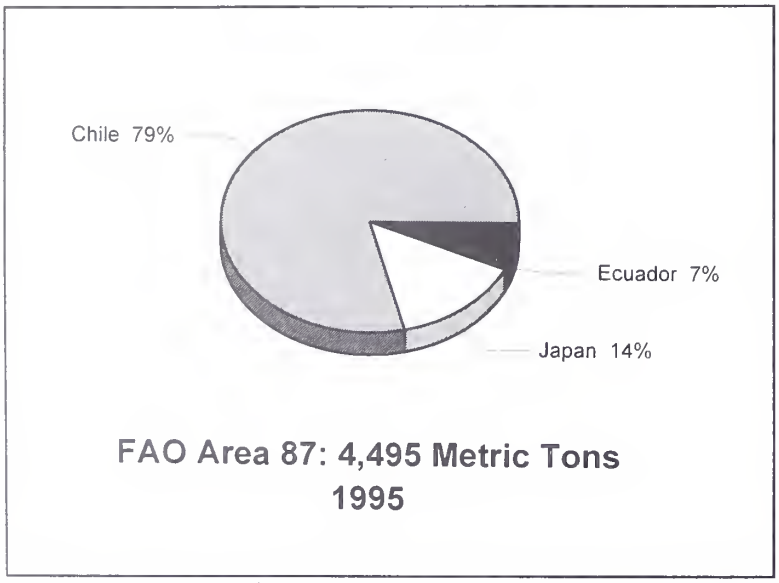

Figure 15.--Japanese swordfish catches in the southeastern Pacific (FAO Area 87) peaked in 1992 and have declined substantially, similar to the Chilean catch pattern.

Tropical waters: Seasonal patterns at tropical latitudes are complex and difficult to assess. There may be some linkages with the seasonal patterns in the temperate area of the southeastern Pacific. For example, the best swordfish fishing season in a substantial area of the eastern Pacific at tropical latitudes is the first quarter. This is a period when the fish are generally not found off Chile in substantial quantities.[62] It is impossible, however, to assess possible linkages based on available data.[63]

Genetic similarity: Several researchers are conducting genetic studies to better understand stock structure and gene flows. Available assessments are still preliminary and based on a small number of samples. In addition, not all researchers have reached the same conclusion. NMFS has contracted Stanford researcher Block who with Rosel at the University of New Hampshire are working on swordfish. Preliminary results reported in 1995 suggested that, worldwide, there are two deeply divergent clades with differential geographical distributions, similar to certain istiophorid billfish. Genetic tests revealed significant geographic partitioning among the three ocean basins, indicating that swordfish are structured on a global basis. There appear to be exchanges between the Atlantic and Pacific-Indian Ocean basins, probably around the tip of South Africa (35°S) because this would be at latitudes and water temperatures within the normal species range. (See "Distribution") The southerly passage around the tip of South America (55°S) is less likely as it would be at latitudes beyond normal ranges.[64]

Wider Pacific: Current genetic research indicates an apparent lack of strong genetic subdivision throughout most of the Pacific. Gene flows within the Pacific are apparently very high. This appears plausible and fishing data indicate that swordfish are widely dispersed throughout the Pacific. While there are clear clusters of good fishing theoretically representing unusually high abundance, there are few tropical and temperate areas where swordfish are not present.[65] The lack of strong genetic subdivision within the Pacific appears to support the single Pacific stock theory.[66] Some geneticists theorize that the population in much of the wider-Pacific appears "to belong to a single related clade." Genetic exchanges

among populations within ocean basins appear high.[67] Research on Pacific swordfish genetics continue by several groups. Researchers working on Pacific swordfish are encountering a more complex population than previously believed and developing more refined methods.[68]

Southeastern Pacific: Some current genetic research suggests a greater separation of Pacific fish than initially anticipated. The Instituto de Fomento Pesquero (IFOP) has supplied some Chilean samples to Block and her associates who have tested the samples and found significant differences with other Pacific fish. This is strong evidence of a possible separate southeastern Pacific stock. The authors of this report stress, however, that genetic research is relatively new and the number of samples assessed from the southeastern Pacific are very limited. Block and her associates, for example, have only assessed small numbers of samples from Ecuador and Chile along the western coast of South America. Their preliminary results, do show little genetic diversity between the Ecuadorean and Chilean samples, but significant diversity with samples from other Pacific fisheries.[69] It is premature, however, to conclude that there is definitely a separate southeastern Pacific stock. Such a conclusion is still tentative and not shared by all genetic researchers. A Japanese geneticist, for example, using different methods from the U.S. research group has not found evidence confirming a separate southeastern Pacific stock.[70] It is unknown to what extent the Japanese researcher has sampled southeastern Pacific fish.

Oceanography: The oceanography of the southeastern Pacific would appear to offer conditions for the development of a separate stock. There is evidence in some areas that swordfish use current flows as migratory pathways, especially in areas of strong current flows.[71]

Humboldt Current: The Humboldt Current (Chile/Peru Current) creates a coherent large marine ecosystem (LME) off the western coast of South America.[72] (See "Fishing Grounds".) While the current is strongest off Chile and Peru, the impact of the current is seasonally noticeable into equatorial waters off Ecuador--but less so off Colombia (figure 16).[73] The influence is partly reflected in the similar species mix and shared stocks, including prey species, found from central Chile north to Peru. It would seem plausible that swordfish distribution would extend to the areas inhabited by principal fodder species. Swordfish may be following the flow of the Humboldt Current north along the Chilean coast for at least part of the year. (See "Migrations".)

South Pacific gyre: Some observers note a south Pacific gyre at latitudes off Chile (figure 17). The counter-clockwise current flow of the gyre does appear to match some of the seasonal shifts noted for swordfish off Chile. (See "Species: Migrations/ Seasonality".) The gyre would bring swordfish along the Chilean coast to feed and then north and west into warmer water to spawn. The authors know, however, of no data confirming such movement, other than some seasonal catch data.

Underwater topography: Some researchers have begun to study the relationship between bottom topography and swordfish abundance.[74] Fishermen in various regions (Brazil, Ecuador, U.S.--Hawaii, and other areas) have reported good results around sea mounts and oceanic rock croppings. The authors know of no such work for the southeastern Pacific. There are underwater ridges and offshore islands off Chile and southern Peru. (See "Fishing Grounds".) These underwater structures may affect swordfish abundance and distribution. The authors know, however, of no studies assessing the relationship between these studies and swordfish abundance in the southeastern Pacific. The authors have noted repeated references by Chilean, Peruvian, and Spanish fishermen to a year-round population of swordfish, mostly juveniles, on the Nazca Ridge running south from central Peru to Chile's offshore islands.[75] Japanese yield and catch data does appear to suggest some relationship between good results and the Nazca Ridge.[76] The resolution available to the authors of the available data (5° squares), however, makes it difficult to determine with any precision. Some Chilean fishermen operate around the Juan Fernández Islands on an ocean ridge running west from the central Chile.[77] (See "Fishing Grounds".)

Migratory patterns: Swordfish in the southeastern Pacific may be making annual migrations within the area. The primary data suggesting such movements is available seasonal data. The actual pattern involved appears highly complex, but the seasonal data does suggest some possible patterns which appear especially distinct in the temperate waters off Chile. (See "Migrations".)

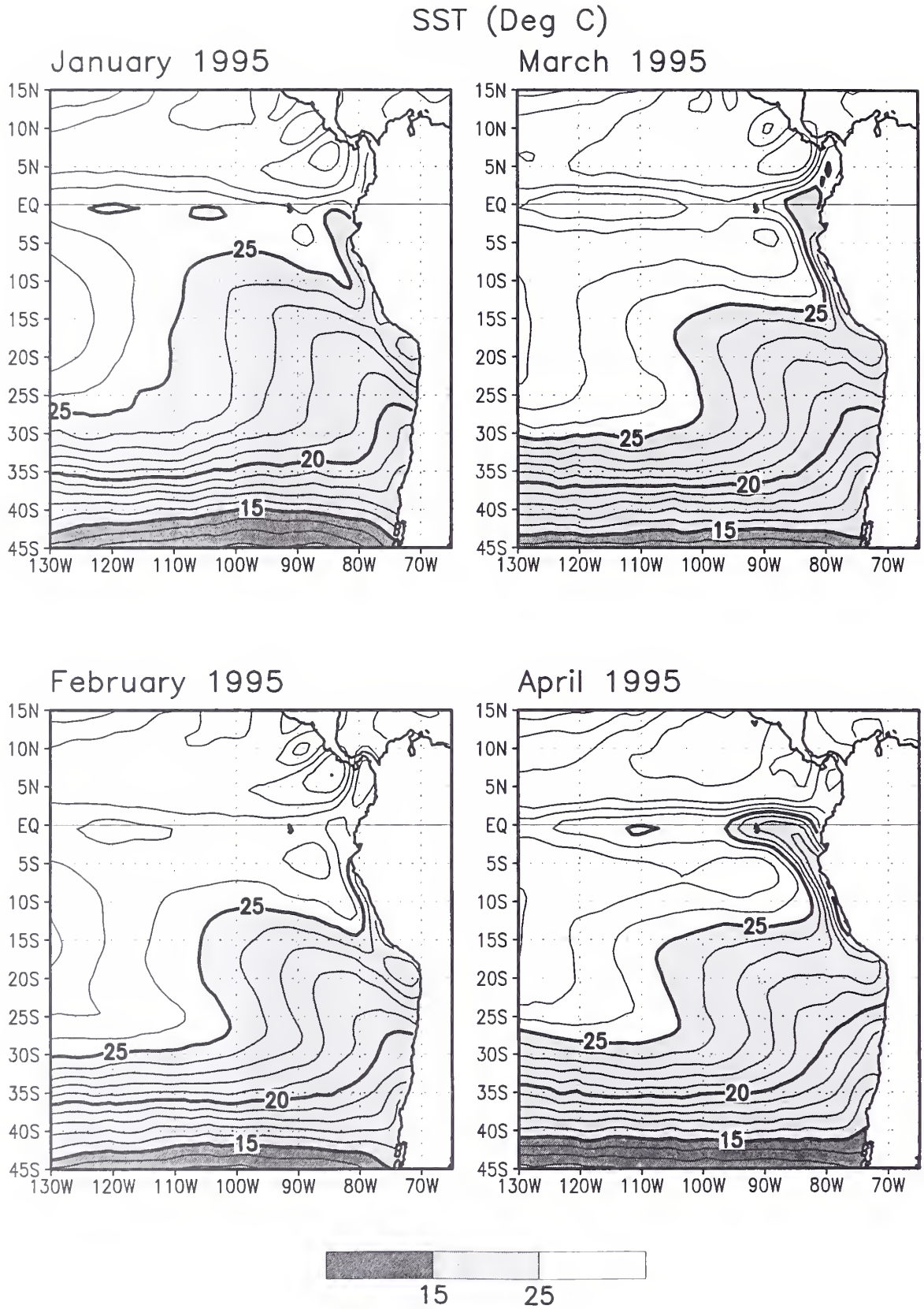

Figure 16-1 --Sea surface temperature (SST) maps of the eastern Pacific.

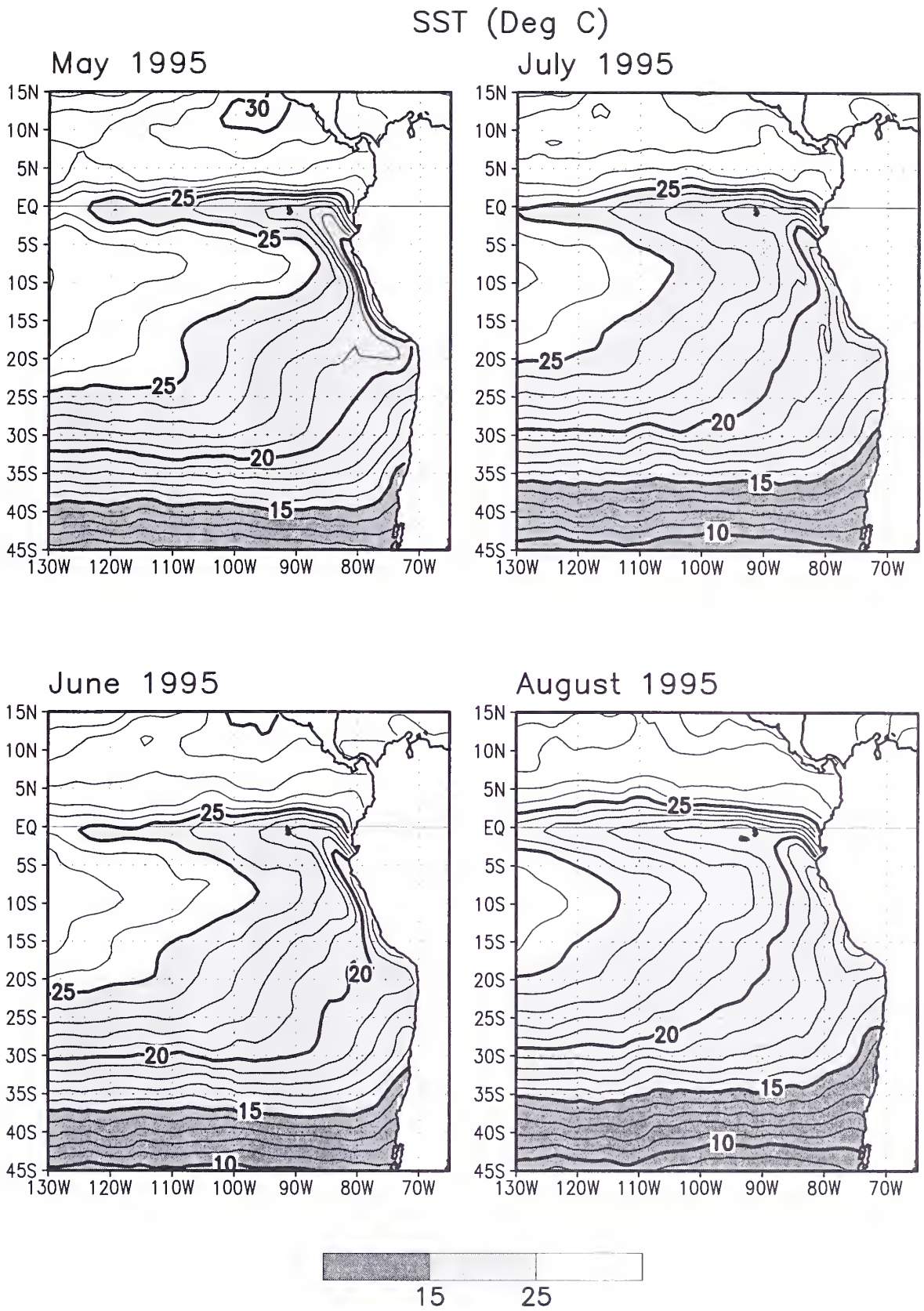

Figure 16-2.--Sea surface temperature (SST) maps of the eastern Pacific.

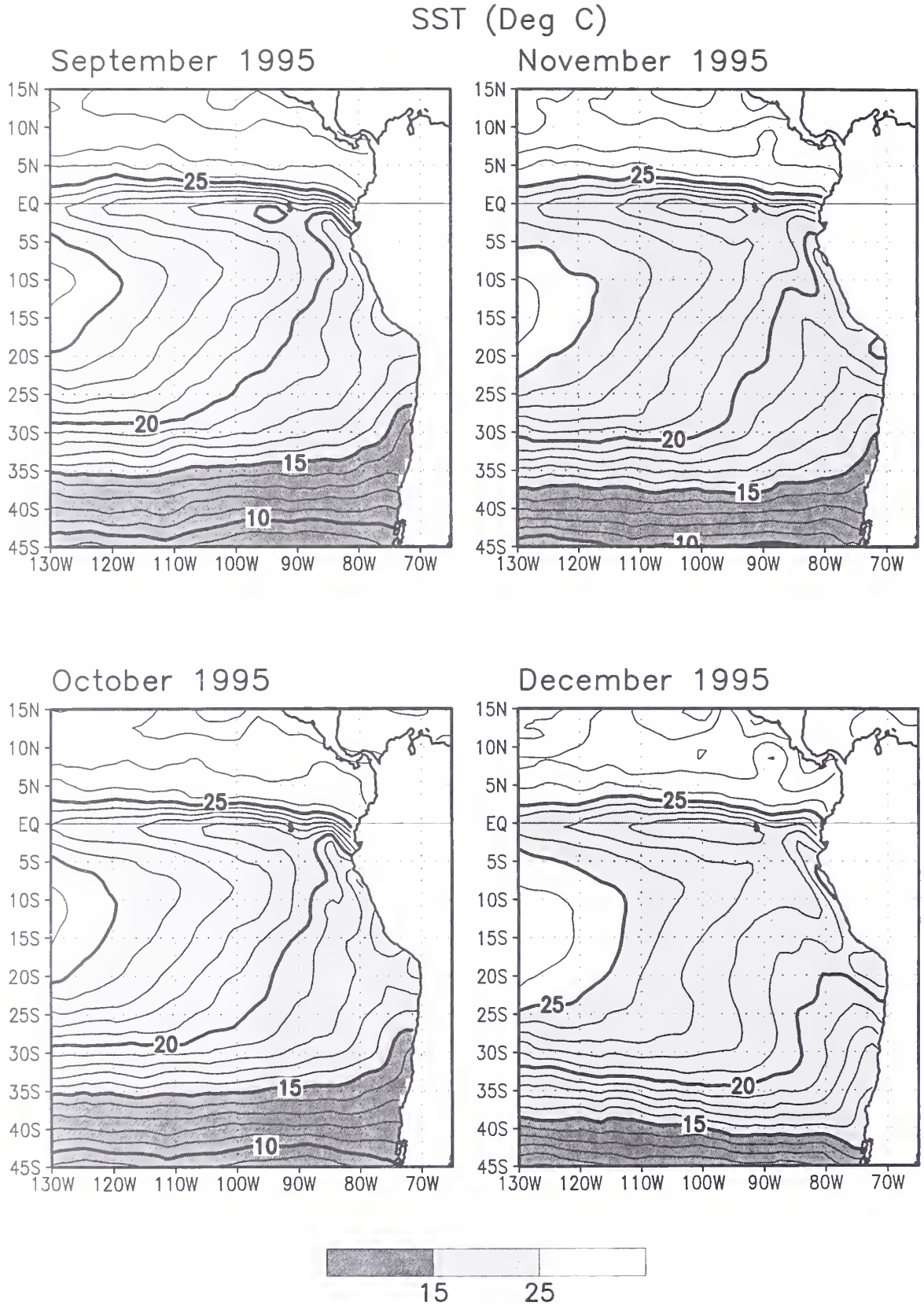

Figure 16-3 --Sea surface temperature (SST) maps of the eastern Pacific.

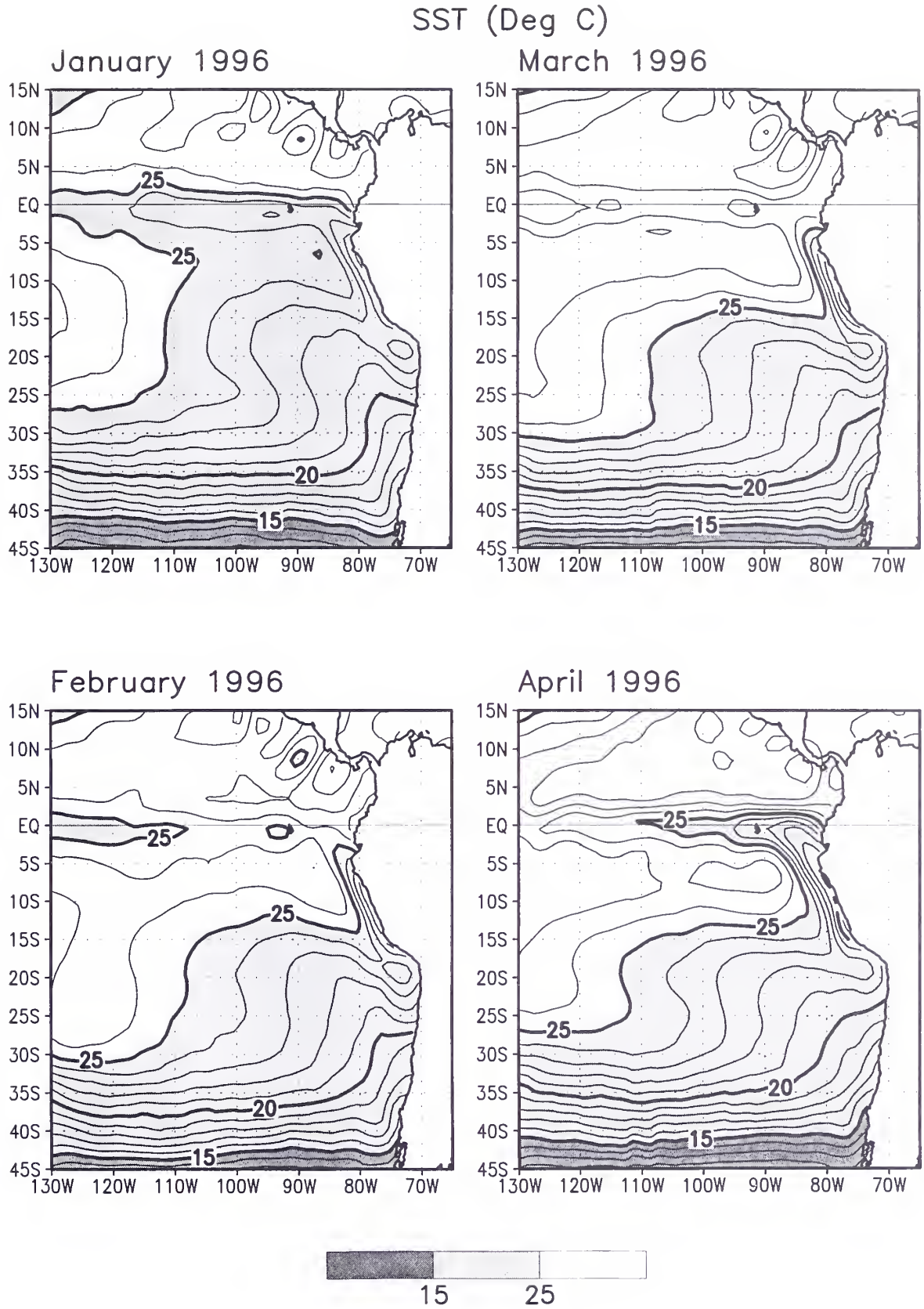

Figure 16-4.--Sea surface temperature (SST) maps of the eastern Pacific.

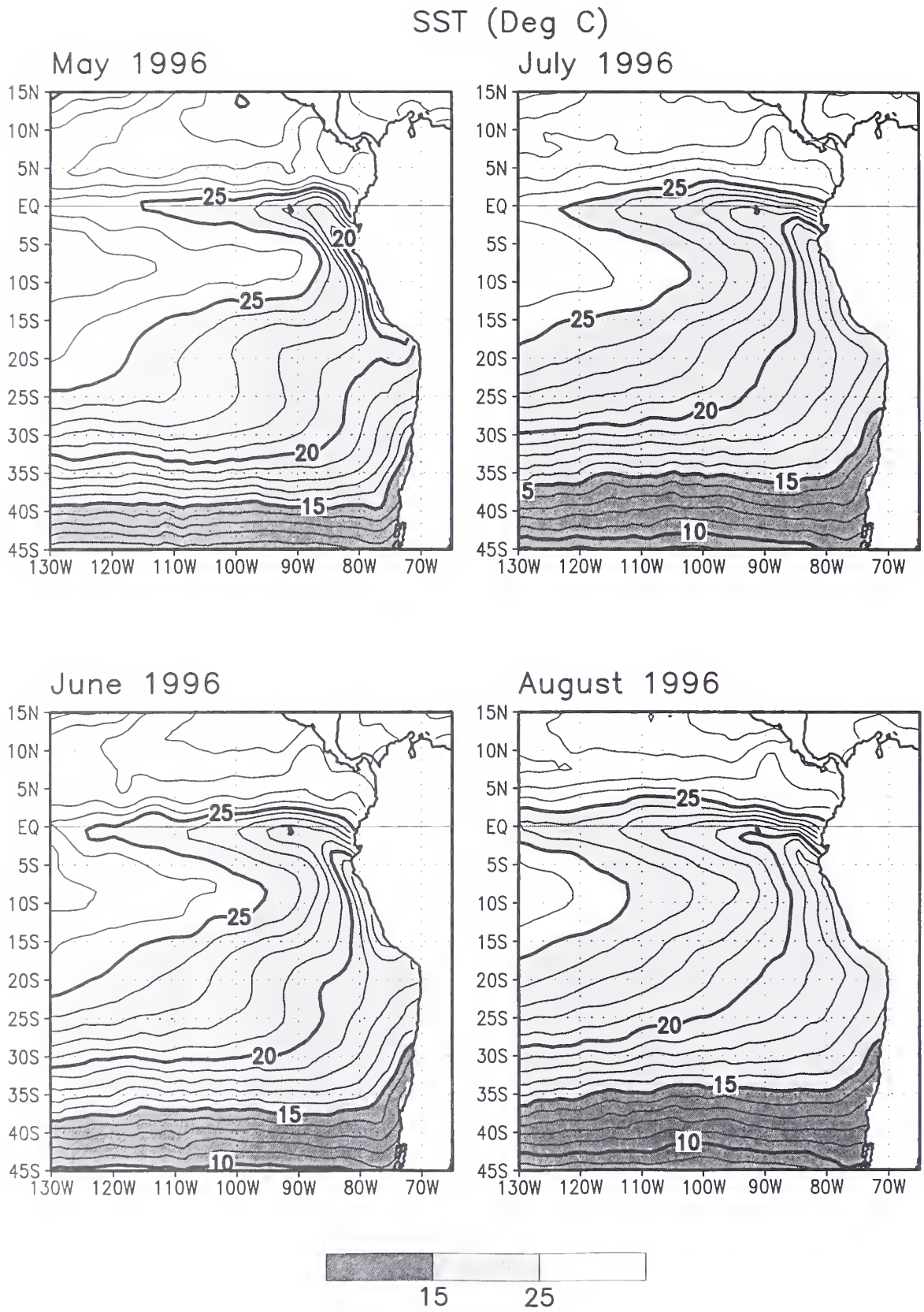

Figure 16-5 --Sea surface temperature (SST) maps of the eastern Pacific

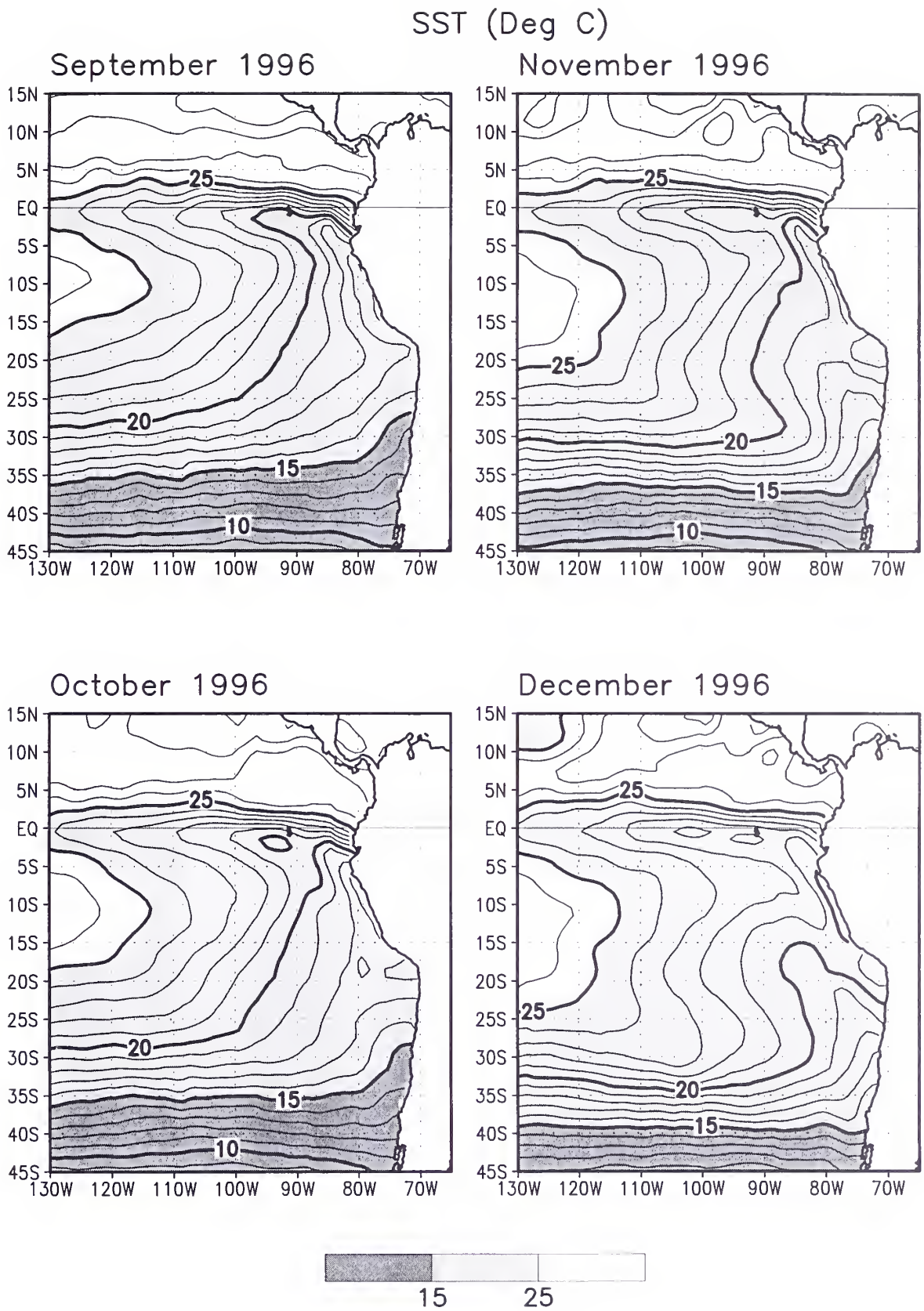

Figure 16-6.--Sea surface temperature (SST) maps of the eastern Pacific.

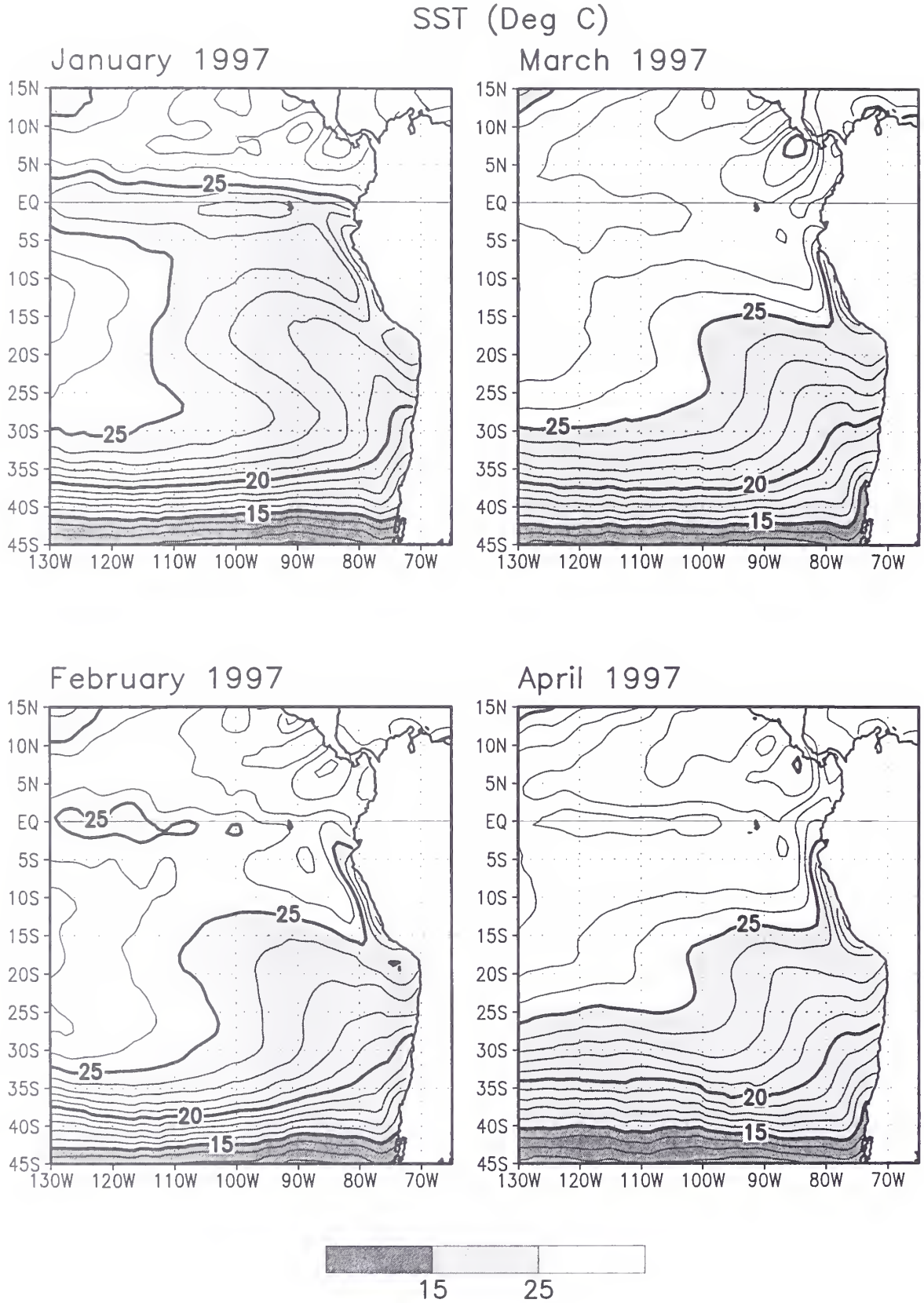

Figure 16-7.--Sea surface temperature (SST) maps of the eastern Pacific.

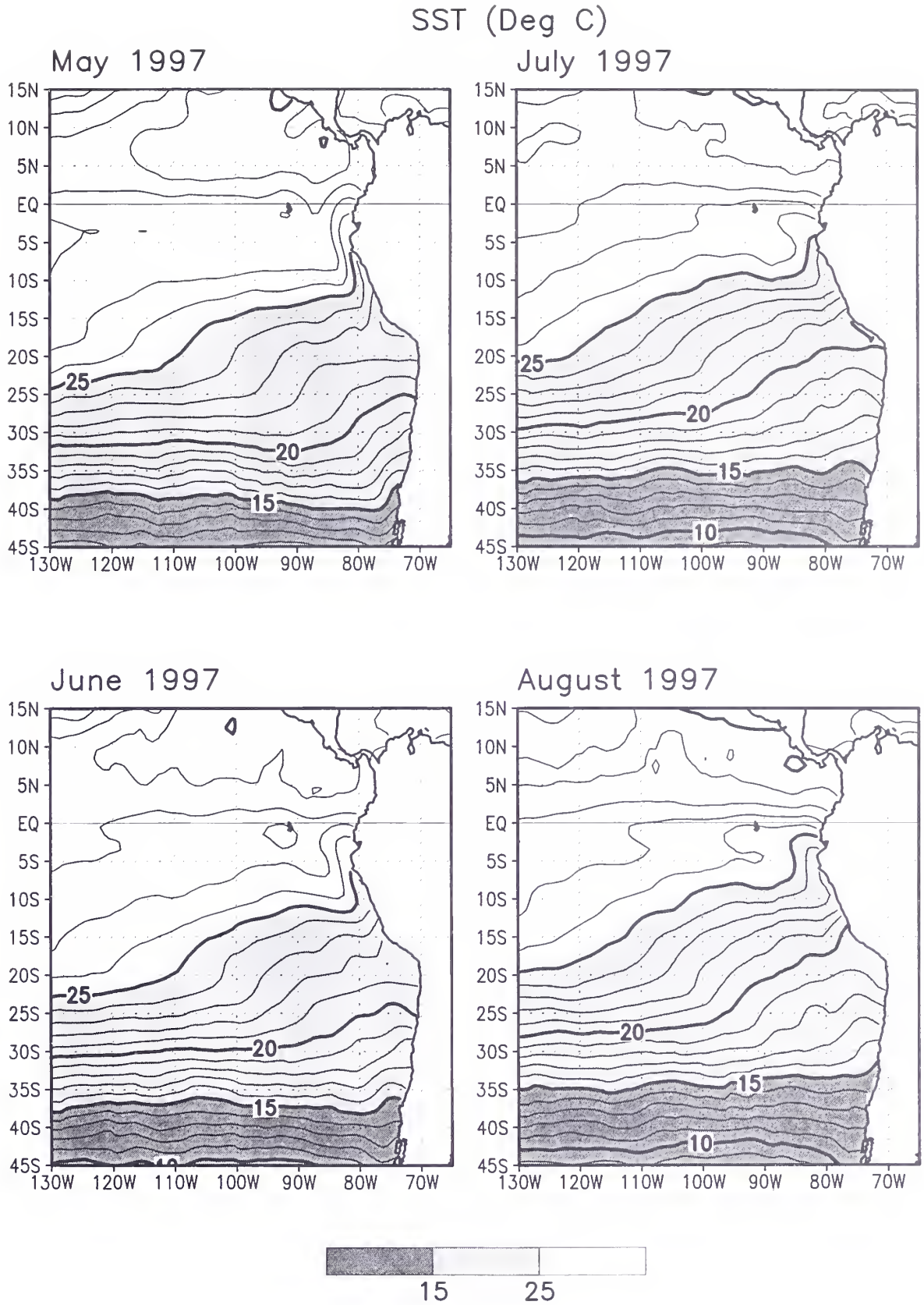

Figure 16-8.--Sea surface temperature (SST) maps of the eastern Pacific.

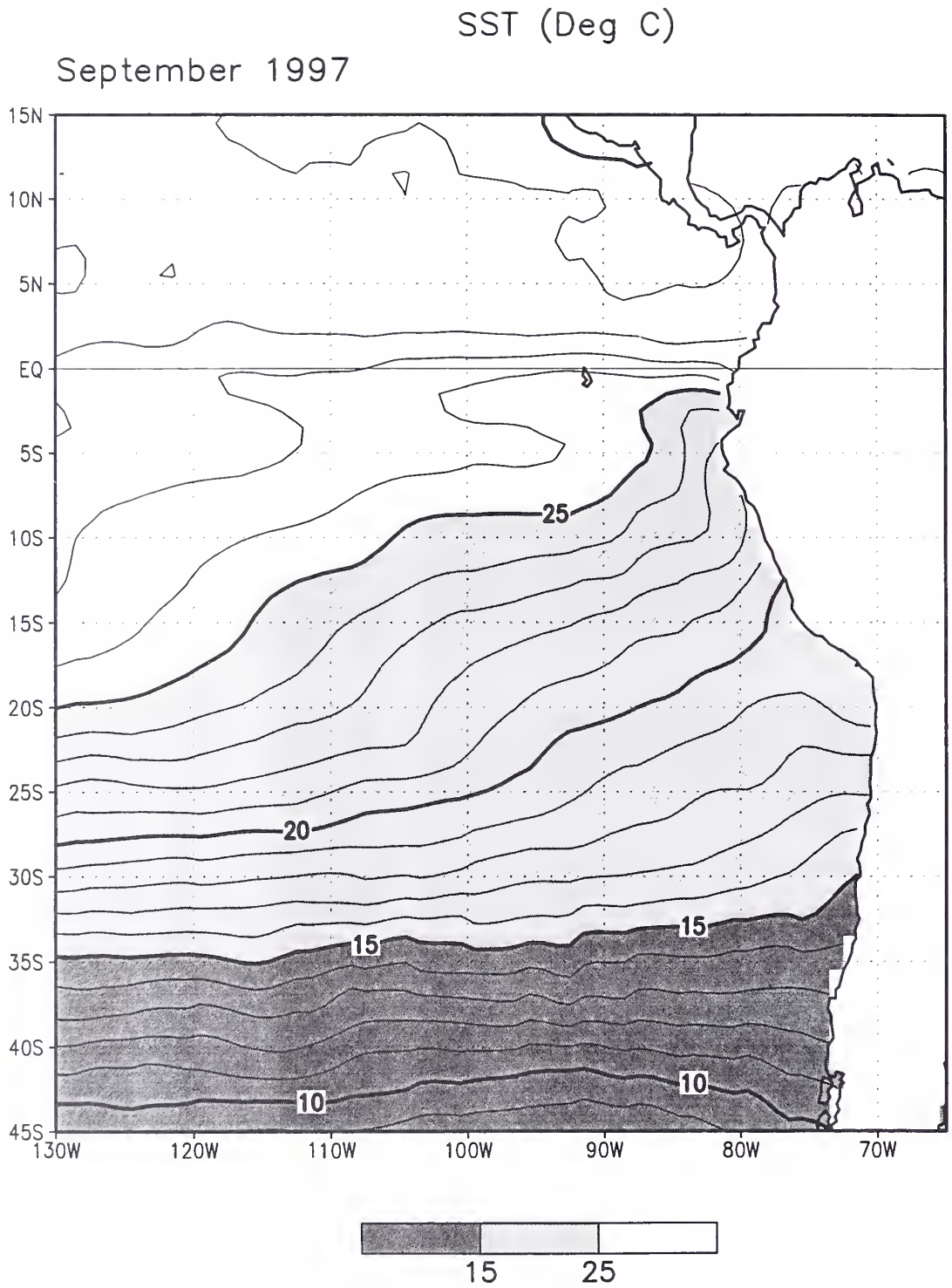

Figure 16-9.--Sea surface temperature (SST) maps of the eastern Pacific.

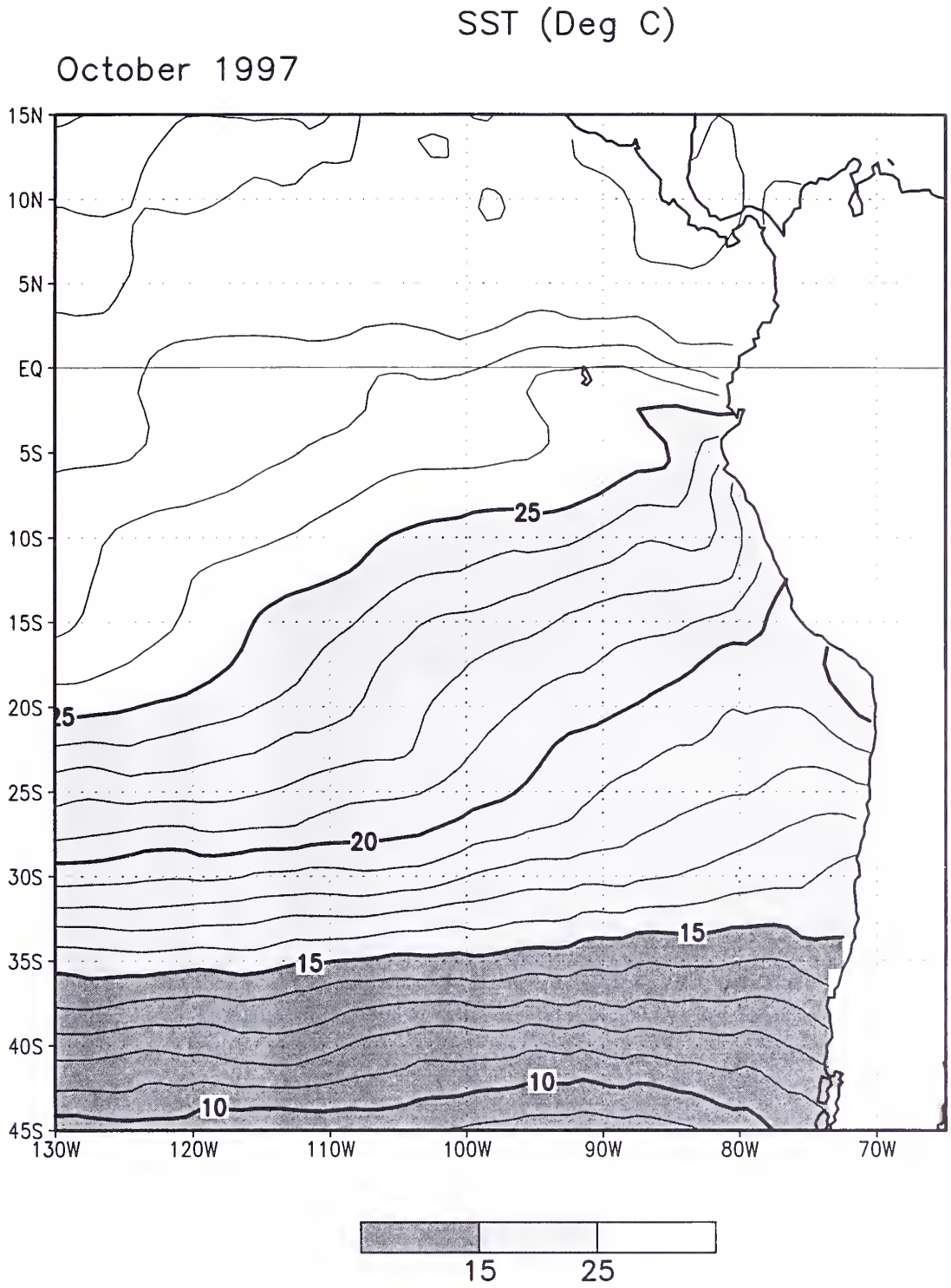

Figure 16-10 --Sea surface temperature (SST) maps of the eastern Pacific.

The relationship of swordfish off Chile with those off neighboring Peru and Ecuador to the north are not know with any certainty. Similar seasonal patterns suggest that the swordfish off Chile and southern Peru are part of the same population. (See "Seasonality".) Chilean researchers are planning a genetic electrophoresis study in an attempt to assess the relationship.[78] Some already existing genetic work suggest that fish taken off Ecuador and Chile have an identical genetic makeup. This would almost certainly mean that fish off Chile and Peru also do not vary genetically. While additional genetic data will add to the understanding of the stock structure, only tag returns can fully confirm migratory tracks. Peruvian seasonal catch data available to the authors is incomplete and current data available during the 1990s is not statistically meaningful.[79] The limited available Peruvian catch data, however, suggests a substantially different swordfish seasonal pattern off northern Peru where most of the catch is landed than noted off Chile (Peru, appendices B4a-b).[80] Foreign catch data also shows significantly different seasonal patterns off Peru.[81] There appears to be an area off the north central coast where swordfish is much less abundant than to the north or south. The seasonal patterns and catch rates are sharply different north and south of this area.[82] This is a possible indication that the Peruvian population, at least the fish off the northern coast, may be different than that off Chile. Some of the recreational fishermen active in the 1950s were convinced that they were separate populations.[83] More likely it simply means that there is no one overriding seasonal pattern for swordfish in the southeastern Pacific.

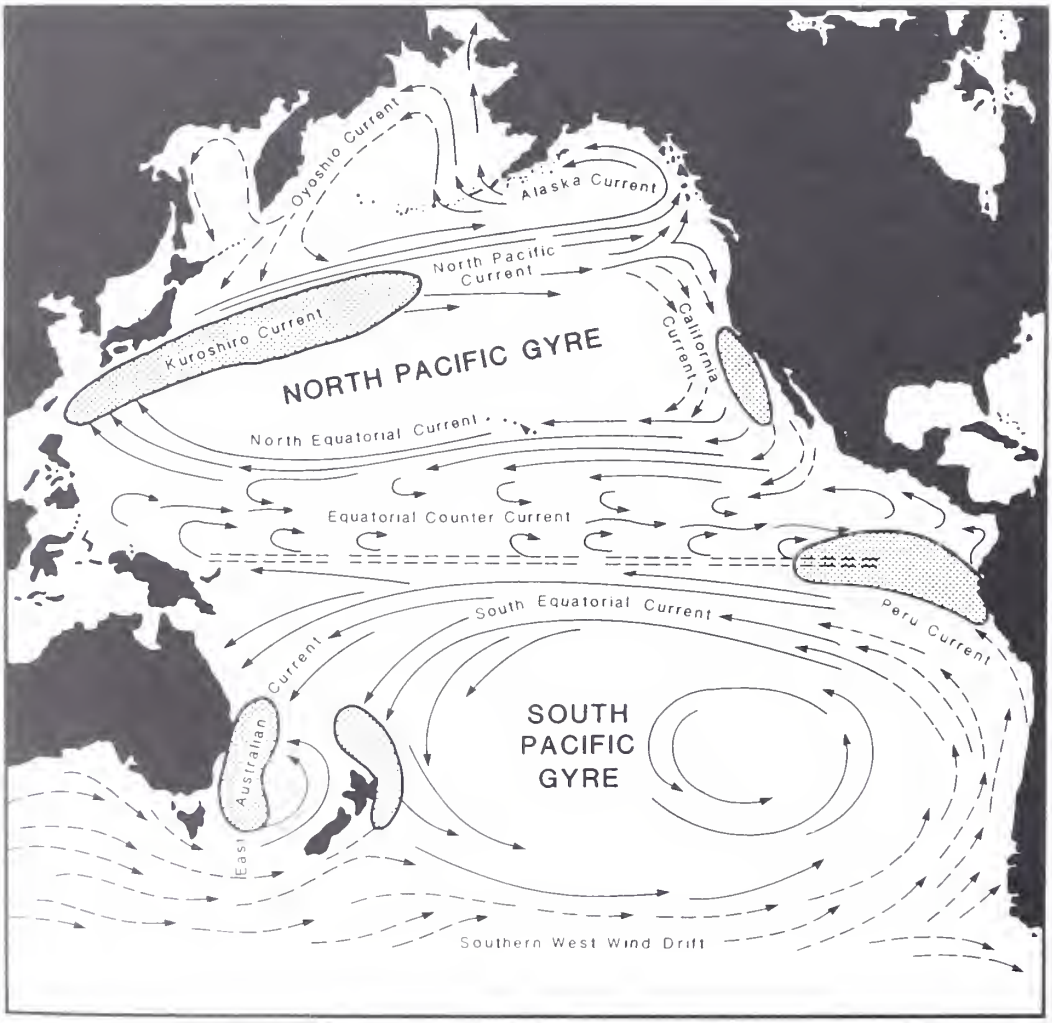

Figure 17.--The South Pacific Gyre may play a role in swordfish migration in this region. Swordfish are often caught in areas of high productivity where currents converge.

The Latin American fisheries (primarily Chilean) on this theorized stock has been centered on the coastal waters off Chile, although Chilean fishermen are increasingly shifting to offshore grounds. This shift was especially pronounced in 1996 as many coastal artisanal fishermen withdrew from the fishery and commercial fishermen, who mostly operated outside the Chilean 200-mile zone, took most of the catch (appendix E2g and figure 65.[84] The other Pacific-coast South American countries land relatively little swordfish.[85] The distant-water fishery (primarily Japanese) is mostly conducted in offshore waters at tropical latitudes off Colombia, Ecuador, and Peru (10°N-15°S).[86] There is also some intense activity at sub-tropical latitudes off southern Peru and northern Chile (15-25°S).[87] (See "Fishing Grounds".)

B. Distribution

Swordfish occur off Chile in both coastal and offshore areas throughout the year, from the Peruvian border (18/19°S) as far south as Valdivia (about 40°S).[88] This conforms with the overall worldwide distribution of the species which is generally limited south of 40°S. The authors know of no detailed study on swordfish distribution off Chile and only scattered reports on test fishing. Some fisheries-dependant data, however, is available.

Chilean assessments: One of the most interesting Chilean assessments of swordfish distribution was published in 1992. The authors did not address overall distribution, but did note a clear shift of the population away from the coast during 1987-91 with negative consequences for the fishermen, especially the artisanal fishermen with small boats. The authors assessed various environmental variables such as sea surface temperatures (SSTs), sea levels, direction and intensity of winds, seasonal shifts, and other factors. They noted a cold period during 1988 and 1990 associated with negative anomalies in sea level and positive anomalies in north-south winds.[89]

Test fishing: The University of Miami in cooperation with the Chilean Government and various companies conducted an assessment of the swordfish stock off Chile during 1956-57. Test fishing using harpoons, lines ("curricán"), and longlines were used in the area around Valparaíso and the Juan Fernández Islands. Fishermen from Iquique participated in the project. The researchers led by John Manning concluded that high winds during the peak fishing season would make recreational fishing difficult, but there was an excellent potential for commercial fishing. The best concentrations of swordfish were found about 40-80 km off Valparaíso. Few fish less than 180 kg were encountered.[90] IFOP conducted test fishing in 1971 using a Japanese longliner. While the target species was tuna (82 percent of catches), a significant swordfish by-catch (10 percent) was noted. The area assessed was east of 110°W and north of Iquique. Further longline test fishing followed in 1979, when the Japan Marine Fishery Resources Research Center (JAMARC) agreed to help assess stocks in the Chilean 200-mile zone and around Easter Island. The researchers reported finding swordfish and stripped marlin in the area between Antofagasta and Valparaíso during July through October. The vessel reportedly caught 7 t of swordfish during 25 sets. This impressed the researchers because the swordfish was taken during a period when the artisanal fishermen were not finding it and with gear and fishing strategies designed for tuna.[91]

Available data from the domestic, foreign, and recreational suggest distribution patterns which have varied over time, providing some possible insights as to distribution. There are major problems, however, associated with using fisheries-dependent data to assess distribution. This is especially true when data from traditional fisheries is used where the fishermen may not have discovered all available grounds or their vessels and gear cannot fully assess even known populations. It is even more of a problem when assessing a highly migratory species such as swordfish. Current fisheries data is more valid because the fishery is mature and fishermen, both foreign and Chilean, have become extremely effective in finding and harvesting the population over an increasingly wide area of its range. Even so, there are other limitations of even the current data. The available Chilean data is primarily port landings data, although IFOP in 1994 began to collect catch data by fishing area. There is also foreign fishing data by ocean area. The foreign data, primarily Japanese, however, has to be carefully assessed. Chilean enforcement of its 200-mile zone prevented Japanese fishing in coastal waters. In addition, as the target species is bigeye, Japanese fishermen have not heavily target oceanic areas in the cooler water at latitudes off central Chile.

Chilean data: Most available Chilean data has limited utility in assessing distribution as it is port landings data. IFOP has only recently begun collecting catch data by ocean area which will more clearly show possible distribution.

Landings: Available Servicio Nacional de Pesca (SERNAP) fisheries data is based on the port where the fish is landed rather than the ocean area where the fish was caught (appendix E2e1). Such data has limited utility for assessing distribution because fishermen do not always land their catch at the closest port. The results compiled from the artisanal fishery may be more useful in this regard than commercial landings data because of the restricted autonomy of the artisanal

vessels and focus on fresh product suggest that the landing site may be relatively close to the fishing grounds.[92] Some tentative insights can thus be gained from the landings data which, used with caution, may give some insight into possible population distribution--at least for the age classes targeted by the fishery.[93] (See "Fishing Grounds: Fishing areas.")

Catches: Chile has not been collecting swordfish catch data by ocean area. IFOP beginning in 1994 begun compiling catch data by ocean area which will eventually permit detailed assessments of catches and yields for both artisanal and commercial fisheries (appendices E2h1-2). Such data will be useful in compiling a more accurate assessment of distribution than the landings data currently available.

Foreign data: Foreign catch and yield data provide the most complete data set on longline fishing in the Pacific. Available Japanese and other Asian longline data provide detailed catch and yield trends over an extended time period. The foreign data, however, has some limitations. The foreign data off Chile, with some exceptions, does not show extensive fishing in Chilean coastal waters or in oceanic areas at latitudes off Chile.[94] This does not necessarily mean that swordfish are not present. Chilean restrictions on foreign fishing have prevented foreign fishing along the coast. In addition, the Japanese focus on bigeye has drawn them to tropical latitudes where bigeye is most abundant.[95] There is thus relatively little Japanese effort in the cooler oceanic waters at temperate latitudes of the southeastern Pacific and, as a result, relatively little is known about swordfish abundance in this area.

Chilean fisheries data indicates that the domestic fishermen have targeted various grounds over time. It is not known fully understood, however, if the shift in grounds by the fishermen reflect actual changes in the distribution of the fish over time. The fishermen, for example, may have shifted grounds because new gear and larger vessels gave them the capacity to assess previously unfished areas. A variety of other reasons could explain the shifting grounds. The available fisheries data does provide some, albeit imperfect, insights into possible shifting swordfish distribution over time. Of particular interest is the shift west of the Chilean fishery during the 1990s culminating in the 1996 season when most of the catch was taken outside the 200-mile zone. It is unclear if this is temporary or a long-term shift in the fishery away from the coast reflecting an actual change in

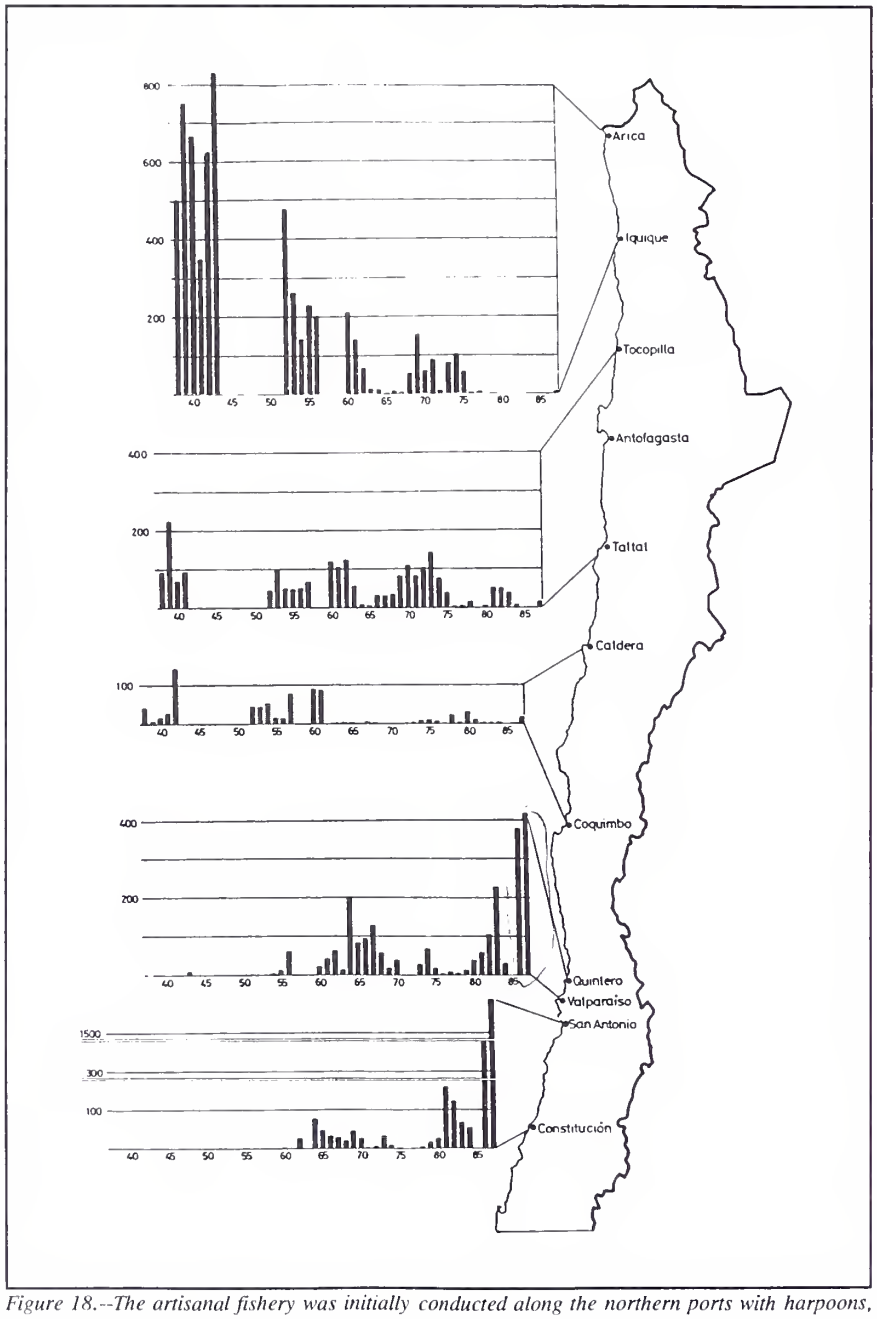

Figure 18.--The artisanal fishery was initially conducted along the northern ports with harpoons, but subsequently shifted to the central coast. M.A. Babieri.

distribution.

1930s-50s: Artisanal fishermen targeted swordfish in coastal waters during the 1930-50s, almost entirely from northern ports (figure 18). The limited range of the small open boats used restricted operations to coastal waters. (See "Fleet" and "Gear and Fleet Operations".) It is not known if the fish during this period were also plentiful along the central coast. This artisanal fishery peaked in 1946 and declined during the 1950s (appendix E2a1 and figure 92).

1960s-mid-80s: The artisanal fishery declined to extremely low levels, especially during the late 1970s (appendix E2a1). Harpoon fishing in the north continued through the mid-1970s, but at much reduced levels. Fishermen during the 1960s began shifting operations from the northern to the central coast, although activity fluctuated in the two areas during the 1970s (figure 18). It is not known, however, if this reflected an actual change in the distribution of the fish.[96] The intensity of harpoon operations declined sharply during this period.

1985-91: Artisanal fishermen began deploying driftnets in the mid-1980 and reported outstanding swordfish catches in coastal waters, primarily along the central coast. Commercial fishermen in 1988-89 also began deploying longliners in more northerly offshore waters. Catches increased rapidly during the late 1980s, more than doubling in some years (appendix E2a2 and figure 93). The catch peaked at nearly 7,300 t in 1991

1992-95: Fishermen beginning in 1992 reported a series of precipitous declines. Both artisanal and commercial reported having to fish at increasing distances from the coast. The artisanal effort was still centered on the central coast (appendix E3b1 and figure 22). Less information is available on the commercial longline fleet, but available data suggests that they operated primarily off the northern and north central coast (appendices E2h1-2). The catch declined to less than 2,600 t in 1995 (appendix E2a2).

1996: Artisanal fishermen reported increasing problems finding swordfish in coastal waters within range of their vessels and many withdrew from the fishery in 1996. As a result, most of the 1996 catch was landed by the commercial longline vessels. The commercial fishermen shifted operations substantially to the west. Most of the catch was, for the first time, taken beyond Chile's 200-mile zone (appendix E2g and figure 14). Preliminary reports indicate the fish was taken about 480-640 km offshore at latitudes along the northern coast.[97]

Data from the historical and current fisheries suggest the following distribution patterns in domestic, foreign, and recreational fisheries:

Domestic fishery: Data from both historical and current fisheries offer some insights into swordfish distribution. Chilean artisanal fishermen have reported catches along both the northern and central coasts (photo 22). Since the 1950s they have shifted the focus of their operations from the northern to the central coast (figure 18). Chilean commercial fishermen have fished over a much shorter time span and have more consistently targeted the northern and northcentral coasts. These fisheries have reported significant changes in the quantities landed and many innovations in vessels, gear, and fishing strategy. Domestic fishermen have reported impressive catches of swordfish off the northern coast. Catches in the 1940s peaked at 2,100 t (appendix E2a1 and figure 92). After the fishery began expanding in the mid-1980s, the best catches were reported along the central coast. The fishermen during the 1990s, however, gradually had to move further and further away from the coast. The catch peaked at nearly 7,300 t in 1991, primarily

Photo 22.--Artisanal fishermen tend to operate along the central coast, while the commercial fishermen tend to fish off the northern coast. Dennis Weidner.

along the central coast. (See "Catch".) Another major shift in the fishery occurred in 1996 and for the first time most of the catch was taken outside Chile's 200-mile zone, at latitudes off the northern coast. These fluctuations could reflect a changing distribution. Oceanographic events as well as longer term oceanographic cycles, for example, are known to affect distribution. The shift of the fishery, however, could also reflect a variety of other factors not related to distribution, such as the changing gear, fishing strategy, market trends, and employment opportunities, as well as a variety of other factors.

Historical fisheries: Swordfish have been harvested off Chile for centuries, although little is known of the fishery until the 1930s. These early fisheries provide some information on the presence of fish in coastal waters, but given the small boats used provide no information on distribution in oceanic areas.

Pre-Colombian era: Archeological records of pre-Colombian civilizations show that swordfish were consumed, although there is no information on fishing strategy and technology. Swordfish remains were found in communities along the central coast.[98] The authors, however, know of no study plotting the frequency of such finds by coastal area.

Harpoon fishery: The artisanal harpoon fishery was first reported during the early 1900s, although its origins may be earlier. Catch data is only available since the late 1930s (figure 91). The fishery centered primarily in northern ports around Iquique (figure 18). It is unclear to the authors if swordfish were only abundant along the northern coast or for some reason more accessible to harpooning in the north. The species does not seem to have been fished along the central coast at any intensity until the mid-1960s. Virtually all of the catches were taken in coastal waters as the small artisanal vessels were not capable of extended trips to offshore grounds.

Current fishery: Domestic fishermen report that the fish is seasonally abundant in both coastal and offshore waters off the central (north of 40°S) and northern coast. The initial operations conducted in the mid-1980s were close to shore, but the fishermen in recent years have had to move further offshore. It is unclear if this represents a natural shift in distribution, a declining stock, the fishing out of coastal populations, or other factors are involved.

Artisanal: Domestic artisanal fishermen primarily target coastal grounds. The artisanal driftnet fishermen initially operated very close to the coast, often about 55-65 km off shore.[99] The fishermen gradually have had to move increasingly further offshore, especially during the 1990s (photo 24). Gradually many artisanal fishermen began withdrawing from the fishery. This process culminated in 1996 when many artisanal fishermen withdrew and their catch, taken in coastal waters, plummeted (appendix E2g and figure 64).

Commercial: The commercial longline fishermen have to operate beyond a 120-mile (192 km) coastal zone reserved for the artisanal fishermen. (See "Government Agencies and Policies".) Commercial effort has varied significantly in the 1990s, but the fishermen consistently moved greater distances offshore. This tendency culminated in 1996 when most artisanal fishermen withdrew from the fishery and the commercial fishermen shifted to grounds outside the country's 200-mile limit (appendix E2b and figure 14).

Foreign fishery: Some swordfish catch data is available from foreign fishermen for the eastern Pacific, but for a variety of reasons probably is not a good indicator of abundance. Foreign distant-water fishermen (primarily Japanese) have reported good yields and catches off southern Peru and extreme northern Chile (figures 11 and 13).

Photo 23.--Small-boat artisanal fishermen conducted a substantial harpoon fishery during the mid-1940s along the northern coast, only a few continue harpooning.

Photo 24.--Artisanal harpoon fishermen operated very close to shore because of their small boats. Directed harpoon fishing is now rare. Dennis Weidner.

On the whole, however, foreign fishing has been modest both in coastal and oceanic areas off Chile. This lack of effort should not be taken as a reflection. of actual abundance. Fishing by neighboring countries (Peru and Argentina) is minimal, but in the case of Peru does not reflect actual distribution.

Distant-water countries: The primary distant-water fishing country targeting tuna and swordfish off Chile has been Japan (appendix E5 and figure 19).

Japan: Historical data (1952-85) show that Japanese fishing off Chile appears to have seasonally achieved some high yields Ecuador, figure 7 and Peru, figure 10). Catches for the most part appear to have been relatively close to the coast, but outside the 200-mile limit. Minimal yields were reported in oceanic waters, although during October and November some reasonable yields were reported as far west as 100°W. After November most of the fishing appears to shift north (figure 10).[100] Actual recent (1991-93) catch data shows a hot spot of excellent results off southern Peru and northern Chile west of 75°W.[101] This may have been primarily on the Nazca Ridge. Available Chilean Naval reports tend to confirm the absence of significant Japanese activity at latitudes off Chile (appendix D4).[102] Japanese and other foreign longline data suggests target areas well into the central Pacific at longitudes out to 150°W, but at equatorial latitudes.[103] Available data shows much more limited fishing in temperate oceanic areas off Chile.[104] This would suggest that swordfish may be less abundant in temperate oceanic waters. As the Japanese primarily target bigeye, however, their limited swordfish catch at these latitudes may only reflect limited effort due to their bigeye fishing strategy. As a result, little reliable information is available on swordfish abundance in oceanic areas at latitudes off Chile.

Spain: Spanish fishermen, to a lesser extent, are also active in the Pacific (Peru, photos 36-46). No actual data is available, but anecdotal reports suggest the Spanish fish at latitudes from Ecuador south to central Chile--outside the 200-mile zone.[105] The focus of their operations, however, appears to be from southern Peru south to central Chile.[106] Chilean Navy reports suggest operations off Chile as far south as 43°S (appendix D4 and photo 25).[107] Less information is available on how far west in the southeastern Pacific the Spanish fishermen are operating. One report suggests operations off Peru and Chile at 80-84°W, or about 800 kilometers.[108]

Neighboring countries: Little current data is available from neighboring countries on swordfish distribution.

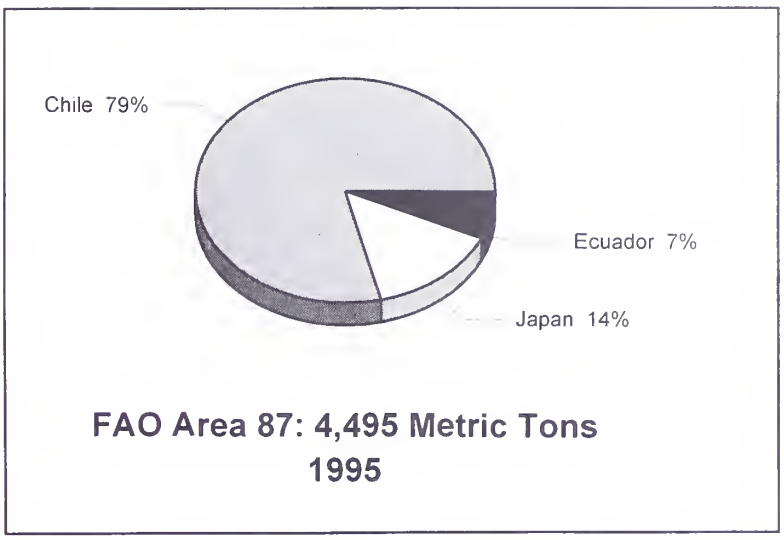

Figure 19.--Japan is the major distant-water country taking swordfish in the southeastern Pacific. The Spanish are also active, but do not report their catch.

Peru: Peruvian fishermen reported very substantial catches during the late 1940s and early 1950s. Most of the catch during this period and subsequent years was landed along the northern coast (Peru, appendix B3 series). That does not mean that the fish were not present during this period off the southern coast, but rather appears to reflect a lack of effort. There were some attempts to develop a domestic tuna longline fishery during the early 1990s. Some of these projects reported a swordfish by-catch (Peru, photo 52). The projects failed for a variety of reasons, none associated with an inadequate resource.[109] Peruvian catches are currently minimal, but various Peruvian companies in 1997 are attempting to initiate a longline fishery. (See "Companies".) Again the minimal catches through 1996 do not mean the fish were not present, but simply continue to reflect a lack of fishing effort. Preliminary reports from one of the Peruvian companies initiating operations in 1997 are very promising (Peru, appendix B8a1). Catches reported by the foreign distant-water fishermen substantiate that swordfish are present off Peru in commercial quantities along the southern coast.[110]

Argentina: Argentine fishermen have taken swordfish, but off the northern coast in the Common Fishing Zone shared with Uruguay (Argentina, appendix C1).[111] Argentine swordfish catches are currently minimal. Companies are deploying a growing longline fleet (Argentina, appendices A2c1-3), but it targets demersal species. Waters along the Chilean-Argentine border in the south are beyond the normal temperature range for swordfish.

Recreational fishermen: U.S. and other recreational fishermen have pursued swordfish off South America since the 1930s. These fishermen in the 1930s and 1950s reported considerable success off both Chile and Peru (photo 25).[112] Much of the recreational activity off Chile was reported out of northern ports such as Iquique. One noted sport fisherman in particular worked the western coast of South America and found spectacular fishing off northern Chile (photo 25).[113] At the time, northern Chile was the center of the country's artisanal harpoon fishery. The recreational fishery declined after the early 1950s, but the reasons are largely unknown. (See "Gear and Fleet Operations".) There has been some limited foreign recreational fishing during the 1980s. One U.S. fishermen reported disappointing results off northern Peru perhaps due to the seasonality of the fishery, but some success out of Algarrobo along the central coast near San Antonio.[114] Currently there is no Chilean recreational fishing for swordfish.[115]

Photo 25.--U.S. recreational fishermen reported great success off northern Chile in the 1930s and 50s.

C. Migrations

Swordfish migrations along the Chilean coast, like swordfish migrations in general, are not well documented. Swordfish are clearly capable of extended oceanic migrations. The most definitive evidence of migratory movement is tagging data.[116] Researchers have demonstrated significant migrations in the Atlantic through tag returns, although some fish appear to be relatively resident. Very few tag returns are available on Pacific swordfish. Results from the small number of tag returns are mixed, but also include some evidence of significant migration. No tagging data exits for the fish off Chile.[117] As a result, theories on swordfish movement off Chile are based primarily on observations or data gathered from the fishery.

1. Migratory movement

a. Coastal waters

Some observers believe that the fish may not migrate large distances. One Chilean observer questions the highly migratory nature of the fish off Chile, pointing out that there are very significant differences between the sizes of the fish harvested at scattered locations, suggesting resident populations where the larger fish had been fished out.[118] Several observers have reported the gradual shift of the Chilean fishery west during the 1990s. (See "Species: Distribution".) This also suggests that the fishermen may be fishing resident fish along the coast.

Substantial indirect evidence indicates that swordfish off Chile make significant migrations. The biological needs of the species strongly suggest that the fish in the temperate latitudes off the central coast must migrate out of the cooler water. There is no evidence of any spawning in Chilean coastal waters. (See "Species: Spawning".) The fish must at some stage migrate into warmer tropical or subtropical waters to spawn. The strongest evidence is the highly seasonal nature of the fishery. Available seasonal data imply that migratory movement appear to be both north-south and east-west. The fish appear to move toward and away from the coast depending on the displacement of warm oceanic water fronts from the northwest.[119]

Coastal waters: Swordfish begin to approach the central coast early in the year and by March the fishery reports substantial catches along the central and north central coast. The fishery then appears to shift north, as the season lasts longer off northcentral Chile than along the more southerly portions of the central coast. The northerly shift of the fishery may be related to seasonal temperature fluctuations as Fall ends and Winter begins (figure 16). There is, however, no definitive proof that the fish are migrating north. Data from the fisheries, both SERNAP catch and IFOP catch data, suggest that the fish are especially abundant off Chile during the cooler part of the year--most of the Fall and Winter (March through July). After July the catch usually begin to decline and most observers believe the fish are moving away from the coast to the west or northwest. While a northern migration appears to be the most likely explanation, other possibilities exist. For example the fish may move in from oceanic areas first along the southcentral coast and somewhat later to the north off the central and northcentral coast.

Beginning: Some Chilean researchers based upon reports from the artisanal and commercial fishermen postulate that the fish approach to within 160 km of the coast during Fall (March/April) especially along the southcentral coast (as far south as about 40°S).[120] Artisanal harpoon fishermen along the central coast often reported the first catches of the year in January or February.[121] Catches during this period, however, are very limited (appendices E3a1-2 and figures 20-21). This early more southerly arrival off Chile could reflect the strength and endurance of the larger fish (mostly females) and their ability to tolerate the colder temperatures at southerly latitudes. IFOP catch data generally confirms that the fish first appear in the south (appendix E2h2). Foreign catch data also reports the first fishing along the central/southcentral coast (30-35°S).[122] Fishermen operating out of Lebu (38°S) often report some of the earliest catches. The quantities taken are small, but the fish are mostly large females.[123] Foreign fishermen confirm the pattern shown by the Chileans. The foreign catch data show that coastal catches begin in the first quarter along the central coast and then continue in the second quarter to the north at increasing intensity.[124]

Peak: The artisanal fishery which is a better reflection of coastal trends than the commercial fishery does appear to show a shift north. Chilean artisanal fishing along the coast begins to reach significant levels in March and April (appendix E3a1 and figure 20). The fishery gradually moves north along the coast.[125] It

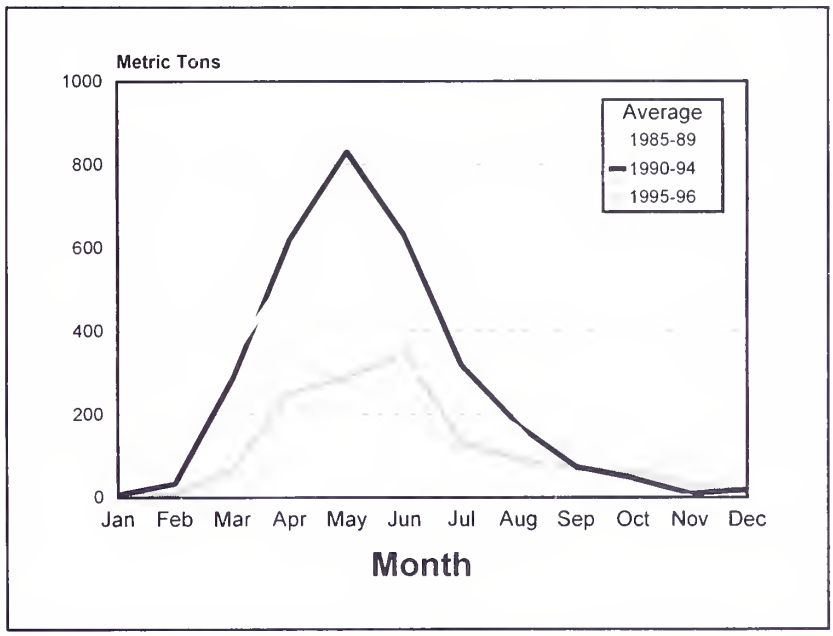

Figure 20.--Artisanal fishermen have reported consistent season patterns, significant catches begin in March and last through July.

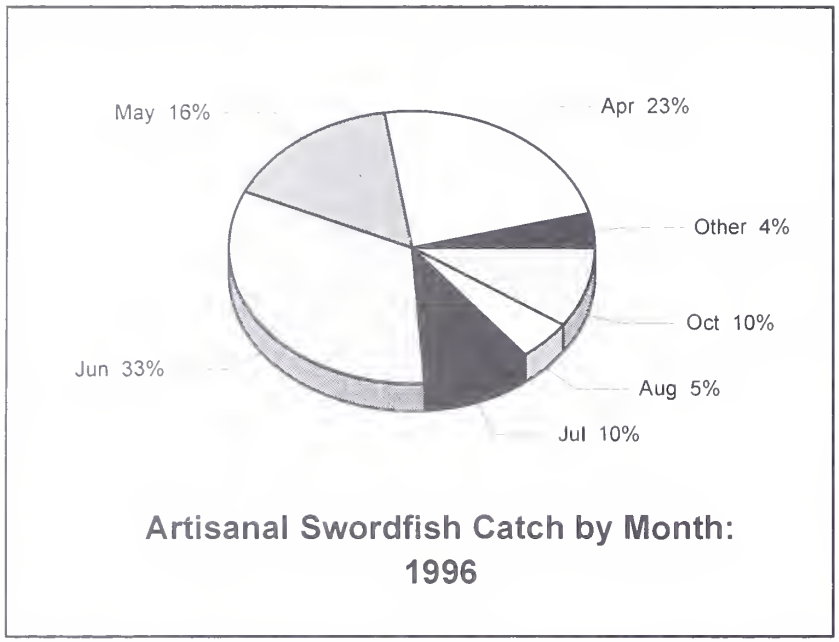

Figure 21.--The bulk of the Chilean artisanal swordfish catch is generally taken in April, May, and June.

would appear to reflect a movement north by the fish, apparently following the flow of the Humboldt Current. Both Chilean artisanal catch and landings data confirm that the fishery peaks from April to June and then declines (appendices E3a1-2 and figures 20-21).[126] The seasonal pattern, however, is somewhat ambiguous and in many year SERNAP reports landings occur along the central and northcentral coast at about the same time (appendices E2d1-2). The mobility of the boats means, however, that landings along the central coast, especially Valparaíso and San Antonio do not necessarily represent fish caught off these ports. The important swordfish port of San Antonio reports extensive activity throughout the main fishing season (March to July/August). Normally from 60-80 percent of the artisanal catch, which is taken in coastal areas of the EEZ, is landed at Region V ports (primarily San Antonio) (appendices E3b1-2 and figures 22-23). This is partly because the port of San Antonio is relatively close to Santiago's international airport where the fish are air freighted to export markets.[127] The fishery in the central region, however, does not generally last as long as that from the northcentral ports (appendix E2h2). This is further evidence of a northerly shift. IFOP catch data by area offers more insight, but data for only 2 years has been published. IFOP reports that in 1995 the first coastal catches of the year were reported off the central coast (Zone 6) during February (appendix E2h2 and figure 24). The IFOP catch data show that catches along the central coast (Zone 6) begin to substantially increase by March. SERNAP also reports significant catches begin in March (appendix E3a1 and figure 20). The fish then appear off San Antonio/Valparaíso (Zone 4) in March and especially April. An increasing proportion is taken off San Antonio (34°S) and Coquimbo (30°S) (Zone 4) as the season progresses (appendix E2h2). Further north off Caldera (Zone 2) catches also begin in March and then more significantly in April, but much smaller quantities then to the south (appendix E2h2). Notably the fish which concentrate in the north off Caldera tend to be generally small individuals.[128]

Decline: The fish continue to be present, but at declining abundance during much of the Winter (July and August) along the central coast. The artisanal catch usually drops sharply in July and August (appendix E3a1 and figure 20). Some good fishing, however, may be occasionally reported in August (appendix E2h1). The latest data (1995-96) suggests the season is beginning later and lasting longer and, as

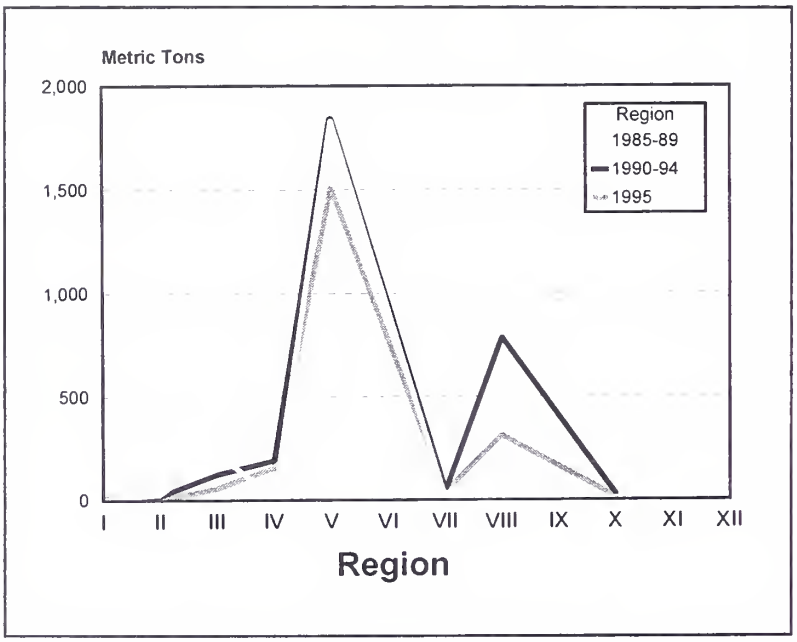

Figure 22.--The bulk of the artisanal catch since the fishery began in the mid-1980s has been landed in Region V, principally San Antonio.

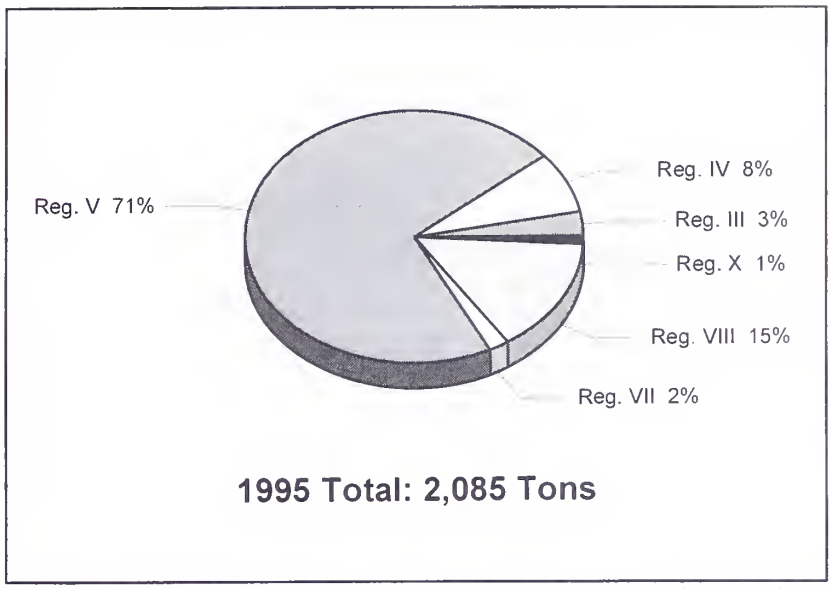

Figure 23.--Chilean artisanal swordfish landings in 1995 were mostly landed in Region V ports which are close to the Santiago International Airport.

complicated than along the coast, and less information is available (photo 26). The commercial landings data collected by SERNAP provides little insight into actual fishing zones. IFOP has only recently begun to collect catch data by ocean fishing area.[132] IFOP zonal catch studies based on observations at sea during mid-1994-95 fishing operations in offshore waters shows no fishing along the central coast (Zone 5). The fishery conducted along the northcentral (Zone 3) and northern coast (Zone 1) show less seasonality and no clear pattern is apparent in the 1994-95 data available to the authors. IFOP reports a mixed pattern off the northern (Zone 1) and north central (Zone 3) coast. During

a result, catches during July and August are becoming more important (appendices E3a1-2 and figure 20).

Cessation: When Winter ends and Spring begins (usually September), landings fall and the artisanal fishermen shift to other fisheries. Swordfish apparently start to move northwest and west, away from the coast.[129] This movement offshore is confirmed by available landings data. SERNAP reports minimal artisanal landings during the Spring and Summer months (November-February) (appendices E3a1-2 and figure 20). This suggests that the fish are least abundant off Chile during this period.[130] IFOP catch data, available only for 1994, show that artisanal fishing fell sharply after August (appendix E2h1). Chilean observers confirm that during this period the artisanal fishermen simply could not find the fish.[131]

Offshore waters: Chilean commercial fishing patterns in offshore waters (until 1996 largely within the 200-mile zone) appear more

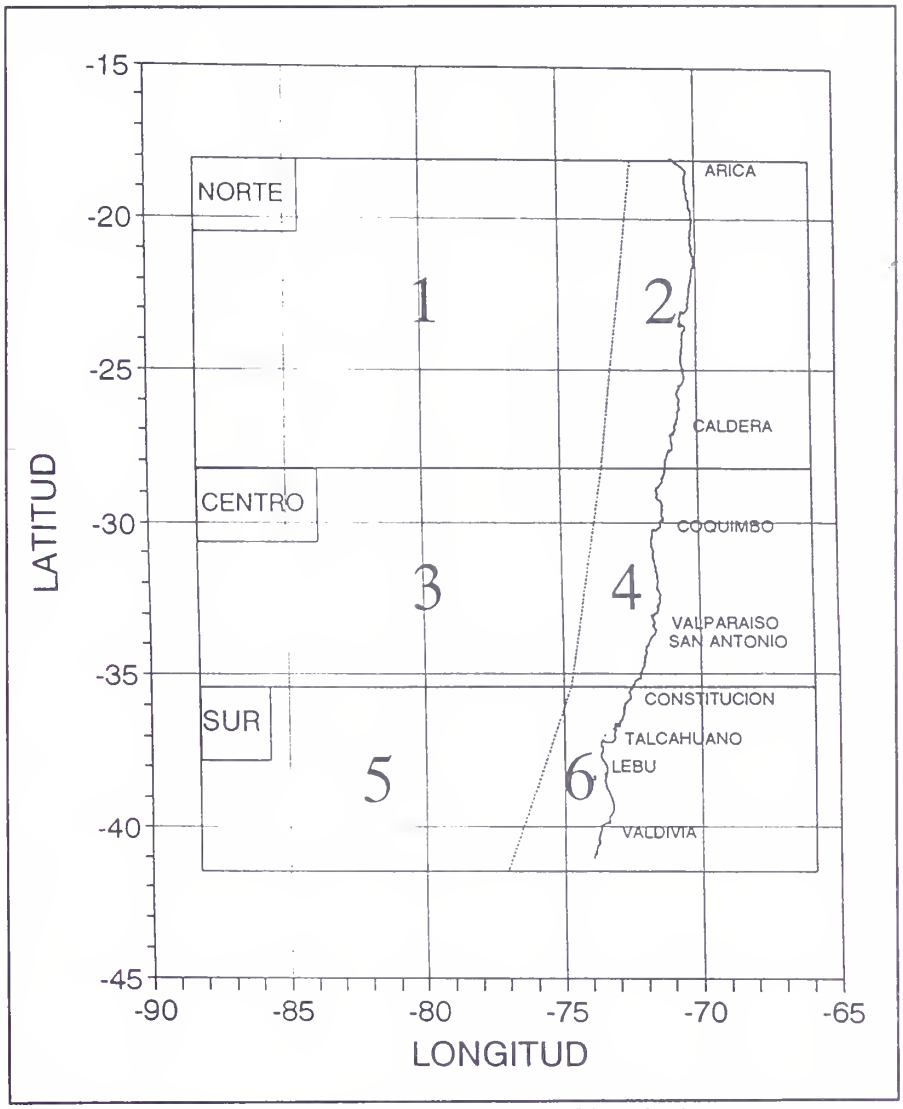

Figure 24.--IFOP statistical areas for collecting data on swordfish catches by ocean areas.

Photo 26.--Commercial longliners are capable of extended voyages, but until 1996 primarily operated within Chile's 200-mile zone. Dennis Weidner.

north as the year progressed from the central oceanic zone (Zone 3) to the northern oceanic zone (Zone 1). The pattern, however, was reversed in 1995 when the commercial fishermen began operating during December in the northern oceanic zone (Zone 1) and in May/June shifted operations southward to the southcentral oceanic zone (Zone 3) (appendices E2h1-2).[133] The short 1994-95 time period and the limited number of months covered, however, preclude drawing any firm conclusions. The authors do note a major shift beyond Chile's 200-mile zone in 1996, further complicating the commercial fishing pattern (appendix E2g and figure 65).

b. Oceanic waters

More extensive foreign data is available for the wider southeastern Pacific. The foreign seasonal data generally confirms the coastal patterns suggested by the Chilean seasonal data and provides some additional insights on oceanic areas not covered by the Chilean data. The foreign data suggests distinct seasonal patterns, although the migratory movement which they represent are still not fully understood. The authors stress that the foreign data comes largely from fishing operations in which swordfish were not the target species which could significantly affect the patterns reported.

Circular: Some foreign catch data shows a seasonal pattern with the fishery moving north along the coast following the flow of the Humboldt Current.[134] This matches the Chilean artisanal data in coastal waters described above. The foreign data in oceanic areas then shows a clear movement west during the fourth quarter as far as 145°-150°W. Less information is available on swordfish seasonality at oceanic latitudes south of 25°S. Some scattered data shows fish as far south as 45°S in the first and second quarters.[135] (See "Species: Seasonality".) Historical Japanese yield data (1952-85) also suggests a circular movement, but only out to about 135°W (figure 25). Notably this circular movement corresponds to the prevailing currents in the southeastern Pacific (figure 17). Such a movement would also appear to meet the basic needs of the fish. It would bring them into Chilean waters during the peak of the jack mackerel fishery, apparently a major prey item in coastal waters. (See "Species: Feeding behavior".) It would also take them into warmer northern latitudes to spawn. (See "Species: Temperatures" and "Spawning".) The data suggesting such a circular movement is incomplete and still tenuous. Further research to assess such a possibility is needed.

East-West: There is a much more apparent east-west movement of the fish off Chile. Foreign catch data shows that the fish are close to the coast, east of 80°W (first and second quarter) and then move into oceanic waters, 80°-100°W (third quarter) and later far oceanic waters, 100°-140°W (fourth quarter).[136]

Northwest: The authors note that foreign fishermen report that swordfish are abundant during the first quarter in a substantial area of the eastern tropical Pacific west of 100°W.[137] The authors know of no data connecting these swordfish with the swordfish off Chile, but note January and February are months in which the fish are least abundant in Chile waters.

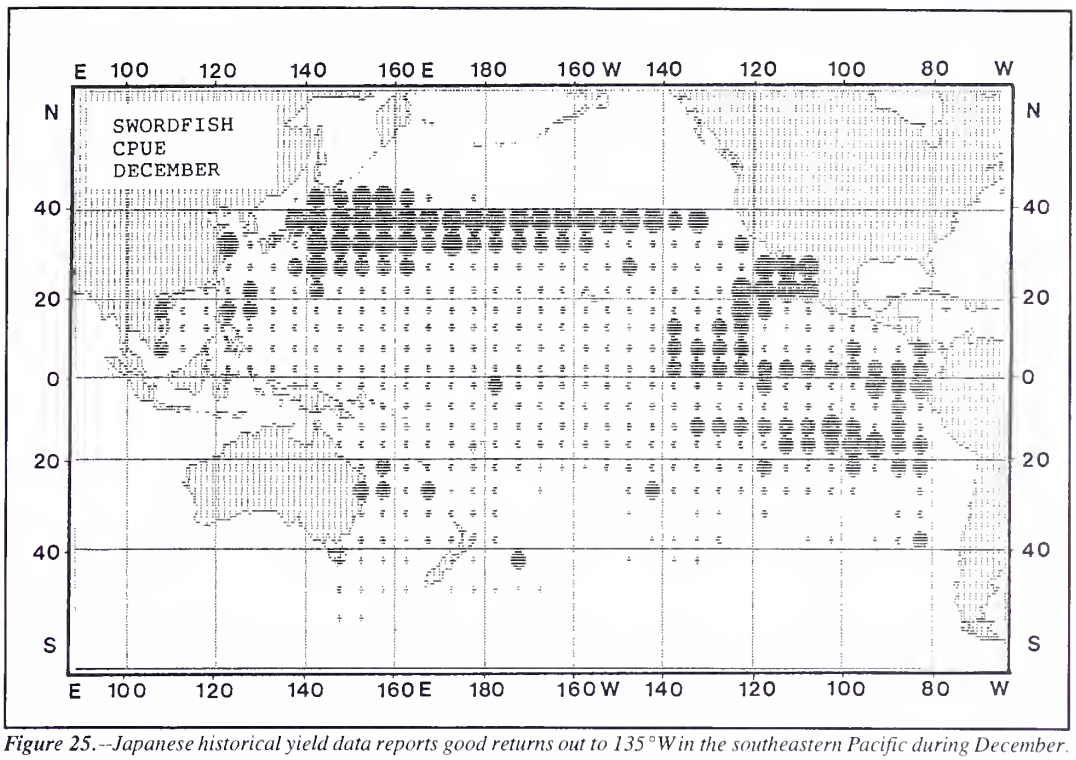

Figure 25.--Japanese historical yield data reports good returns out to 135°W in the southeastern Pacific during December. Sosa and Shimizu.

2. Causes

It is unclear as to precisely what drives migratory movements in the southeastern Pacific. It appears to be an interplay of currents, seasonal temperature shifts, feeding behavior, spawning needs, and other factors--many of which are interrelated. The available data associated with feeding behavior, however, is somewhat contradictory.

Currents: Foreign swordfish catch patterns appear to correspond with major current flows in the southeastern Pacific. The movement north along the coast would correspond to current movements along the coast, especially the northern flow of the Humboldt Current. There is also a circular movement of water in the south Pacific know as the south Pacific gyre (figure 17). The gyre would appear to correspond to the a possible circular movement of swordfish in the southeastern Pacific.

Seasonal temperature shifts: A movement north would bring the fish north out of warmer water which develops off Chile's central coast as the Chilean winter (June-September) ends (figures 16). This may be related less to the temperature requirements of the fish, which are able to tolerate a wide range, then the availability of prey.

Spawning needs: Swordfish spawn in warm tropical or subtropical waters. Available reports indicates that there is no spawning in Chilean coastal waters. (See "Species: Spawning".) The need to move into warmer waters to spawn would seem to require migratory movement northwest, at least by adult fish. Fish occurring in cooler temperate water would seem to have to make longer migrations than fish occurring in tropical waters. (See "Spawning".)

Feeding: Some anecdotal historical and current reports suggest that squid is an important prey item off Chile. Chilean fishermen, however, report minimal squid catches. The lack of current catches, however, does not mean a resource does no exist. The one Chilean research study on swordfish feeding known to the authors was conducted from artisanal boats and suggests indicates that two of the principal prey items in coastal waters are jack mackerel and longtailed hake (appendix B2a and figure 40).[138] IFOP research indicates that jack mackerel may be an especially important prey item for swordfish off Chile. The Chilean jack mackerel resource would seem to offer a huge food potential resource. Notably there is substantial correlation of the peak jack mackerel fishing season and primary fishing grounds with that of swordfish. (See "Species: Feeding behavior.")

D. Temperature

Swordfish have a wide temperature tolerance. the species has the greatest temperature tolerance among billfish, ranging from 5-27°C. This is a key factor explaining the worldwide distribution of the fish. Very few other single species have such an extensive distribution. Researchers in various areas have attempted to determine the temperature range preferred by the species. As the species occurs in both tropical and temperate waters, different populations may have different preferences or their preferences may change seasonally with migratory movement. Japanese researchers report that the optimal temperature for the species in the northwest Pacific is 18-20°C.[139] Is it likely that the fish in other regions at similar latitudes, such as the waters off Chile, have comparable temperature preferences. Chilean researchers in 1964 reported a temperature range of 17-19°C, but found that 18°C was optimal for harpoon fishing. Subsequent studies in 1970 found swordfish in waters with surface temperatures from 14.5-20.3°C and noted optimal temperature of 16-18°C.[140] Chilean studies conducted in 1987-88 report catches in water from 13.5-19.0°C (appendix B3). The species is rarely found in waters when temperatures fall below 14°C.[141] Swordfish tend to avoid the lower temperatures, but may encounter them in foraging dives as deep as 650 m--although dives beyond 550 m are unusual.[142] Chilean northern and central coastal waters are strongly affected by the upwelling which supports large stocks of small pelagic species (jack mackerel, anchovy, and sardines) (appendix E1b and figure 4). (See "Fishing Grounds.") The upwelling can affect swordfish fishing operations because it can cause substantial temperature differences in very short periods of time.[143]

Chilean fishermen report that the optimal water conditions for fishing operations vary seasonally. Chilean artisanal swordfish fishermen report catching swordfish in water ranging from about 13-19°C. There are, however, significant variations as the season progresses: February (19°C), May (17-18°C), and August (13-14°C). Commercial fishermen operating off the northern coast appear to set in somewhat warmer water. One Chilean captain currently working with a Peruvian company in southern Peru near the Chilean marine border (18-19°S) reports during July working in slightly warmer water during July (21-23°C) (Peru, appendices B8a1-2).[144] Another longliner working in about the same area (17-18°S) reports working in somewhat warmer temperatures during May/June (18-21°C).[145]

The artisanal fishermen report in recent years having to travel greater distances from the coast to encounter these temperatures.[146] It is unknown if this represents a long-term climatic shift. There does appear to have been an unusual El Niño pattern during the early 1990s (1990-95) causing abnormally warm temperatures for an extended period. Fishermen report lower catches in the warmer water.[147] Sea surface temperatures returned to more normal levels in 1996 and were actually slightly below normal by the end of the year.[148] A major warming event began in early 1997 which has developed into an important El Niño event (figure 26).[149] Indicators of El Niño events, such as SSTs, during mid-1997 were already exceedingly high, despite the fact that the event does not usually peak until year end. This suggests to many climatologists that the 1997-98 El Niño could prove to be the most powerful ever recorded. It has already had major impacts on a variety of fishery stocks. Many tropical and sub-tropical species are being found at higher latitudes than normally reported. The overall impact on fodder species in the eastern Pacific is yet to be determined. One of the major impacts of an El Niño event is normally a drastic reduction in small pelagic catches off Peru and Chile, especially anchovy. So far the major impact off Chile has been to drive the southern anchovy stock shared with Peru south into Chilean waters, although jack mackerel catches off the central coast have declined somewhat. El Niño events can devastate anchovy stocks.[150] The impact on sardines and jack mackerel is normally less severe. Chile has only recently, however, begun to harvest large quantities of jack mackerel and, as a result, the impact on jack mackerel stocks of a major El Niño combined with the massive Chilean fishing effort is yet to be determined. As a result, the effect on large oceanic predators like swordfish also can not be determined. Information on the current status of the El Niño can be found on a NOAA internet site.[151]

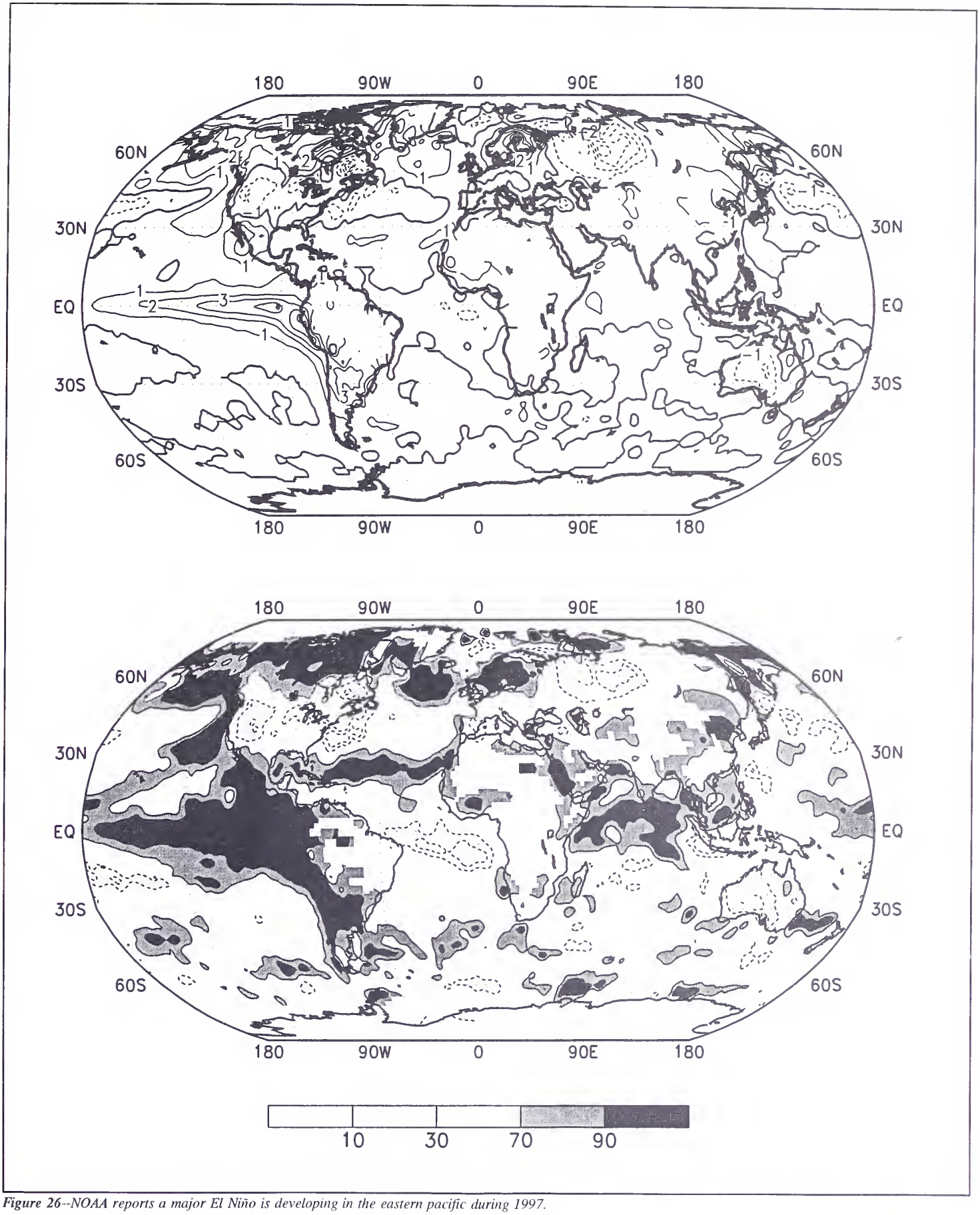

Figure 26--NOAA reports a major El Niño is developing in the eastern pacific during 1997.

E. Spawning

Swordfish do not spawn off Chile's mainland coast. Swordfish do spawn at latitudes off the northern coast, but upwelling and the cold Humboldt Current lower temperatures making spawning unlikely. In addition, spawning does not take place even in tropical coastal areas of the ETP, although the reasons for this are unknown. There is very limited information on reproductive activity in Chilean waters.[152] IFOP and associated universities have begun to address this subject. Other data is available from foreign researchers in the southeastern Pacific.

1. Pacific

Spawning is reported throughout the year in the equatorial Pacific.[153] There is, however, a seasonal pattern. The fish appear to spawn more prevalently in the western Pacific:

Eastern: Gonad-index data suggests that mature fish are not found off Latin America. Mature fish are only found west of 110°W between 10°N and 30°S particularly during the first and fourth quarters of each year.[154] Notably this is the period in which swordfish appear to be least prevalent off the Chilean coast, at least in terms of actual catches (appendix E2c1 and figure 27). As a result, spawning is generally believed to take place west of 110°W and north of 30° S. This would be well beyond the mainland 200-mile coastal zones of Latin American countries, but stretching roughly from Clipperton Island (about the same latitude as Costa Rica) south to Easter Island (about the same latitude as Coquimbo, Chile).

Central: Spawning occurs during the Spring and Summer (March-July).[155]

Western: Mature fish in the western Pacific off Asia occur between 20°N and 20°S.[156] Fish in the southwestern Pacific spawn in the Spring (September-December).[157]

2. Chile

Preliminary Chilean research confirms that the fish are not spawning off the mainland coast. Chilean researchers have initiated studies on swordfish maturation, but data is limited. Foreign sport fishermen collected some data in the 1950s, but these records are not currently available (photo 27). Chilean researchers report that the fish off Chile are not ready to spawn. One study of gonad samples shows that eggs were only in the early stages of development (low gonadal index) (appendix B7 and figure 28). Even large mature fish reportedly have low gonadal development while off Chile.[158] This is evidence that the fish are not in a condition to spawn. A more recent study reports finding some mature fish in September.[159] Notably this is normally the end of the artisanal fishery when most of the fish appear to be moving offshore. (See "Migrations".)

Larval distribution can be used to test available maturation assessments. Available research on the Pacific indicate:

Chile: The presence of larvae is one way of substantiating spawning activity. Chilean researchers have not found swordfish eggs and larvae. IFOP reports that they have not encountered swordfish larvae in their plankton studies which have primarily been conducted in coastal waters.[160] The absence of larvae off Chile is strong evidence that the fish are not spawning.

Other eastern Pacific coastal countries: Swordfish larvae also appear to be absent all along the Pacific coast of South, Central, and North America--with one exception.[161] Ecuadorean researchers have tentitively reported finding small numbers of swordfish larvae in plankton studies in the Gulf of Guayaquil.[162]

Photo 27.--Some recreational fishermen and their wives collected data on swordfish, but the data is not currently available.

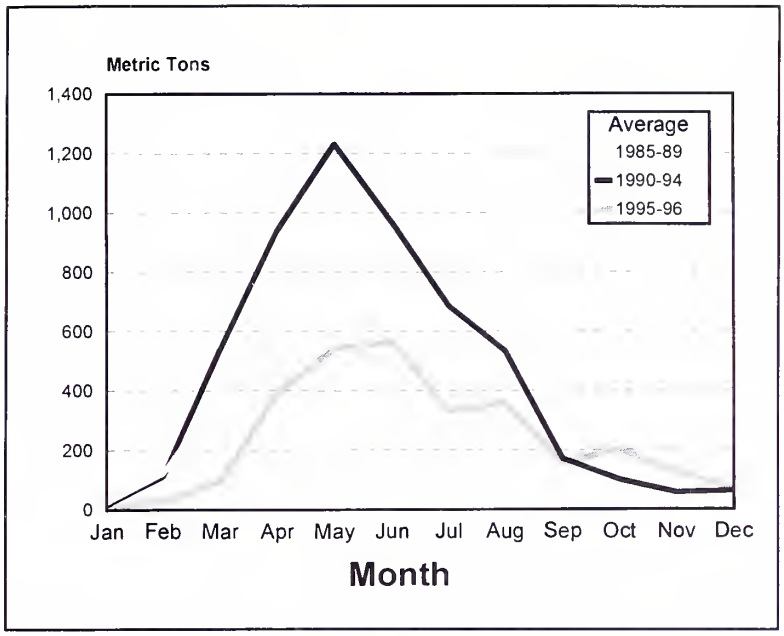

Figure 27.--Swordfish spawn at some distance from the Chilean coast during the first and last quarter of the year, the same period when little swordfish is found off Chile.

Distant-water countries: Various distant-water fishing countries have conducted extensive plankton surveys in the Pacific. These researchers have so far found no swordfish larvae in coastal and oceanic areas of the eastern Pacific, east of 108°W.[163] While the research effort in the eastern Pacific has been more limited than in the western and central Pacific, the absence of larvae strongly suggests that swordfish are not spawning off Chile and other coastal countries in the eastern Pacific.

Many observers report the presence of small, juvenile fish off northern Chile and Peru, especially on the Nazca Ridge. (See "Fishing Grounds.") Foreign swordfish fisheries are conducted at least seasonally around these features. The authors are unsure as to why this concentration of swordfish occurs on the Nazca Ridge. Concentrations of various species can often be found on sea ridges and mounts as well as other marine features. Fishermen frequently focus operations on submarine features. The impact of ocean currents on the Nazca Ridge as well as other ocean features appears to create habitat conditions, such as inducing upwelling that are ideal for specific species. One likely possibility is that juvenile swordfish find fodder species that are prevalent because of the interplay between the Ridge and currents. Reports of small fish have been reported by recreational fishermen active during the 1950s as well as by the commercial longline fishermen currently active.[164] An IFOP 1994-95 study on fishing zones confirms the presence of small fish in oceanic waters off northern Chile (Zone 1). The longline fishermen were taking fish averaging only 33 kg (trunk weight) in the northern oceanic zone (Zone 1), while taking fish more than twice that size (75 kg) in the central oceanic zone (Zone 3) (appendix B5g3 and figure 29). This raises the possibility that the northern zone may well be a nursery area.[165]

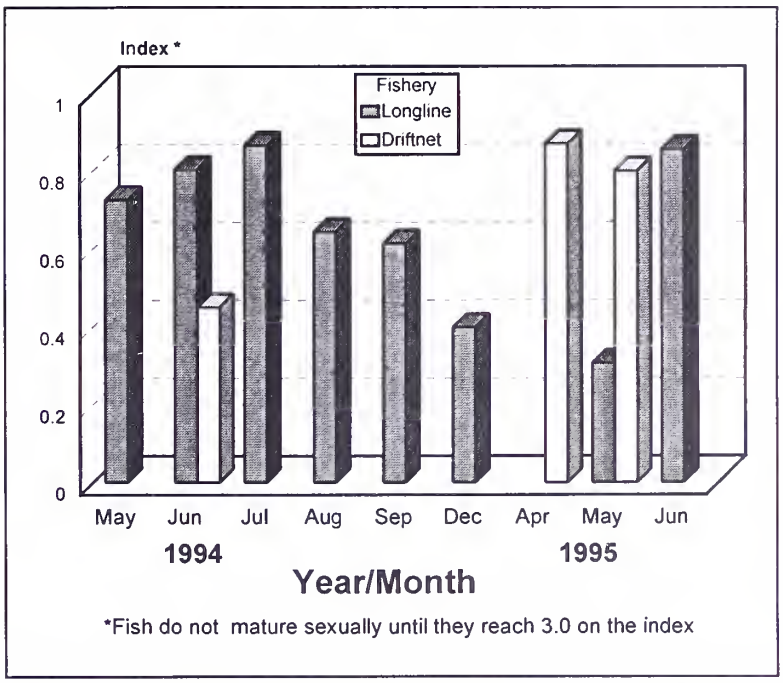

Figure 28.--Samples from both the longline and driftnet fishery off Chile indicate that swordfish are not ready to spawn.

Swordfish reportedly spawn about 2,400-3,200 km off Chile from December to April.[166] This would include the area around Chile's Easter Island (27°S, 109°W), about 3,700 km off the coast. Easter Island is, however, probably close to the southern limit of swordfish spawning. The authors know of no actual research on swordfish spawning off Easter Island, but the reported association of spawning with warmer water temperatures suggest that little spawning takes place much to the south of the Island. IFOP has done some work assessing the general fisheries potential. One project evaluated the Island as a potential basis for a tuna fishery. IFOP found that tuna were plentiful, but that the Island lacked the necessary

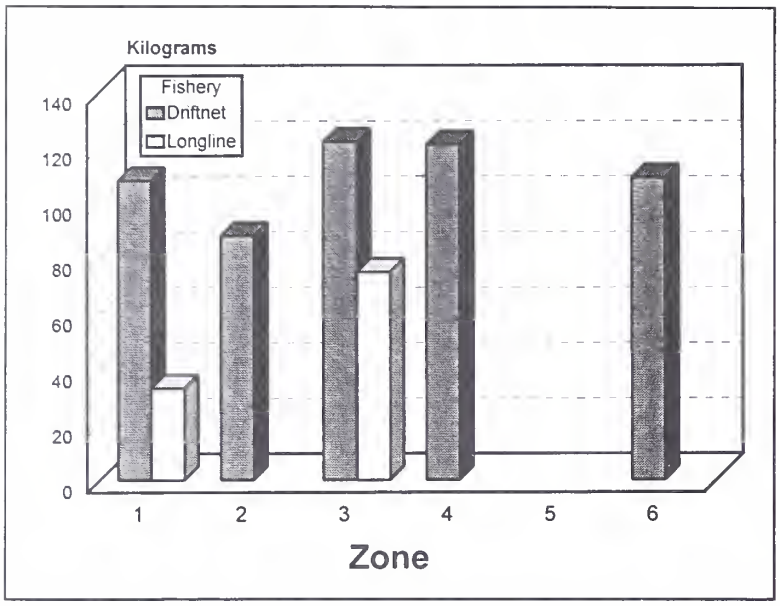

Figure 29.--Longline fishermen take much smaller fish than the driftnet fishermen who report taking similar sized fish in most fishing zones.

infrastructure.[167] There is no fishery data on swordfish available because the Island's small fishing industry is a small-scale operation targeting lobster and other inshore species.

Biologists from other countries have done some work on the ages and sizes at which swordfish spawn. Various researchers have reported a range of results. Differences have been described, both between the Atlantic and Pacific as well as within each ocean. These differences may result from the vagaries of individual research designs. One study from the Pacific and Indian Oceans suggest that female swordfish begin to spawn when they reach about 5-6 years or 150-170 cm (eye-fork) length.[168] A review of the literature indicates that most researchers believe female swordfish begin to mature at 160-170 cm, about half are mature at 200 cm and almost all 220 cm fish are mature (Latin America, appendix B3). While detailed data is unavailable on maturation off Chile, it is unlikely that swordfish in the Pacific (or even in the Atlantic) mature at greatly different ages or sizes.[169] Chilean researchers are addressing this question.[170]

F. Seasonality

The Chilean swordfish fishery is highly seasonal, much more so than the fisheries reported further north in more tropical waters. Both Chilean and foreign fishermen report significant seasonal fluctuations. Given the increasing efficiency of both foreign and Chilean fishermen it is probable that the fishing results off Chile are a good reflection of actual seasonal abundance.

1. Chilean fishery

Chilean fishermen report highly seasonal catches. The seasonal pattern, however, is somewhat different for the various Chilean fisheries, primarily because of the different grounds fished. The general pattern also fluctuates somewhat from year to year.[171] Overall the best catches are usually reported during March and begin to decline after July or August (appendices E2c1-2 and figures 27, 30, and 31). The only months in which catches have exceeded 1,000 t are April, May, and June. Many artisanal fishermen only participate in the fishery for a few months

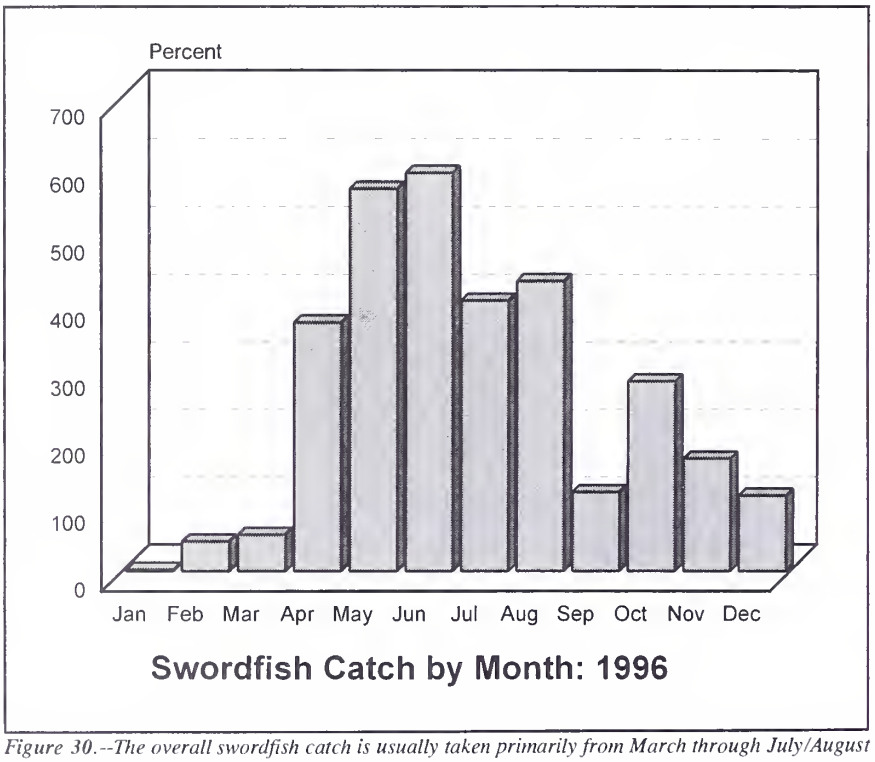

Figure 30.--The overall swordfish catch is usually taken primarily from March through July/August but the March catch in 1995 and 1996 were below normal.

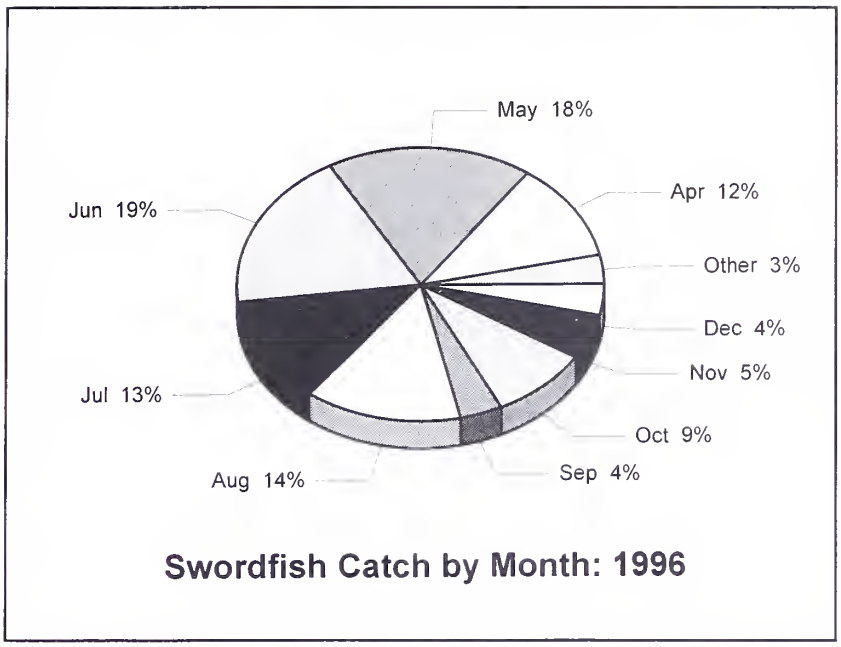

Figure 31. Normally about three-fourths of the swordfish catch is taken from March to August.

beginning in March and then shift to other fisheries when catches begin to decline (photo 75). Nearly 200 vessels were operating for swordfish in May 1993, for example, but only 36 vessels were still fishing by August (appendix A2d2 and figure 32). Catches usually peak from April through June and the largest individuals are also taken during this period.[172]

Harpoon: Harpoon fishermen were significantly affected by the seasonality of the fishery. As the dedicated harpoon vessels were very small artisanal craft, they were limited to grounds relatively close to the coast. The seasonality of the harpoon fishery varied by grounds, presumably because of migratory movement. While dedicated harpooning has declined significantly during recent years, many driftnet vessels are still rigged for opportunistic harpooning and report occasional strikes.[173] The pattern during the 1970s and 80s was:

Central coast: The harpoon fishery began along the central coast (35-32°S) during the Summer months January or February. The major catches were usually reported in April and occasionally March. The fishery then continued until June or sometimes into July.

Northcentral coast: The harpoon fishery was conducted along the north central coast or "Norte Chica" (31-25°S) beginning at the end of summer in March to the beginning of winter in May. Catches in this area, however, are normally minor.

Northern coast: Chile's harpoon fishery during its peak (1930s-40s) was traditionally centered off the northern coast or "Norte Grande" (24-18°S). The fishery in more recent years (1970s and early 1980s) usually began at the end of Summer (around March) and continued through the Winter (until September). The best catches were reported during the late Fall/early Winter (May and June). Fishermen operating out of Antofagasta (located at the southern extreme of the northern coast) reported less seasonal results during several years than the other ports.[174]

Driftnet: The current artisanal drift gillnet or "red de enmalle/pared" fishery, which in most years through 1995 accounted for the bulk of the catch, was taken mostly along the wider central coast (about 41-27°S) in inshore waters. Minimal catches are reported during the Summer (early in the year, January or February) out of the ports around Talcahuano. The catches during these early months are the lowest of the year (appendices E3a1-2 and figure 20). Fishing begins in earnest during Fall (usually March) when significant catches are first reported. Further north in the central region the fishery also begins during March out of Constitución, San Antonio, Valparaíso, and Quintero and continues, somewhat longer than from the ports to the south, often through

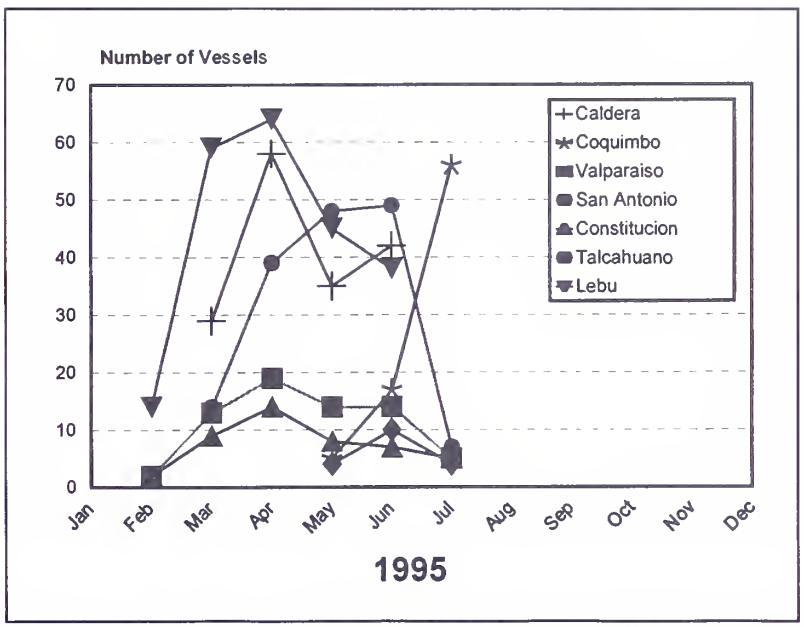

Figure 32.--Artisanal fishermen deploy their vessels for swordfish at the beginning of the year and then shift to demersal fisheries in the second half of the year.

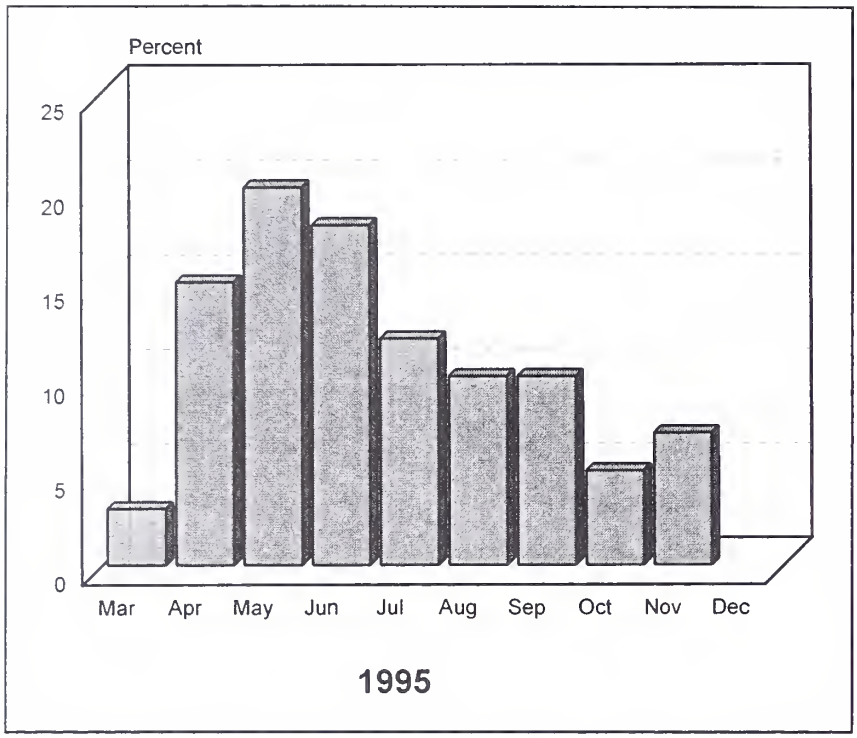

Figure 33.--The commercial fishery within Chile's 200-mile zone tends to be somewhat less seasonal than the artisanal fishery.

August. The fishery can sometimes end as early as July (appendices E3a1-2 and figures 20). Even so, small quantities are landed throughout the year. The season varies somewhat from port to port as the fishery moves north up the coast during the season. (See "Species: Migrations.") The larger vessels follow the fish, but many smaller boats do not have the range to do so.[175]

Longline: The seasonality of the commercial fishery is more complicated. Commercial longline fishermen could theoretically operate all year round. Fish are reportedly almost always available in the northern oceanic zone (Zone 1) and on the Nazca Ridge. (See "Fishing Grounds.") The small fish available there, however, often do not justify commercial operations.[176] As a result, like the driftnet and harpoon fisheries, there is seasonal pattern to the fishery. SERNAP landings data suggest that in the first few years of the fishery (1986-89), when only a few longliners were deployed, the commercial longline season was very short--only from March-June. During the early 1990s (1990-94), the season within 200 miles was longer, roughly March-August, comparable to the season described above for driftnets. The 1995 season was somewhat delayed, however, beginning in April and lasting through September (appendices E4a1-2 and figure 33). The longline operations conducted in international waters during the early 1990s (1991-94) appear slightly less seasonal with landings more evenly dispersed over the year (appendices E4b1-2 and figures 34 and 36). The most recent catches in international waters (1995-96) have continued the pattern of a somewhat longer season (appendix E4b1 and figure 34). The longline fishery outside the 200-mile limit appears to start somewhat later than along the coast. The principal landings are from May to August and continue, but at lesser levels, through December (appendices E4b1-2 and figures 34 and 36).[177] Some of these fluctuations may be due to the withdrawal of many vessels after the 1991-92 peak, leaving a much smaller number of active longliners (appendix A3d and figure 74). One company reports that they had been operating longliners all year round, but as the catches have been declining, decided in 1995 to suspend operations in October and did not resume until March 1996.[178]

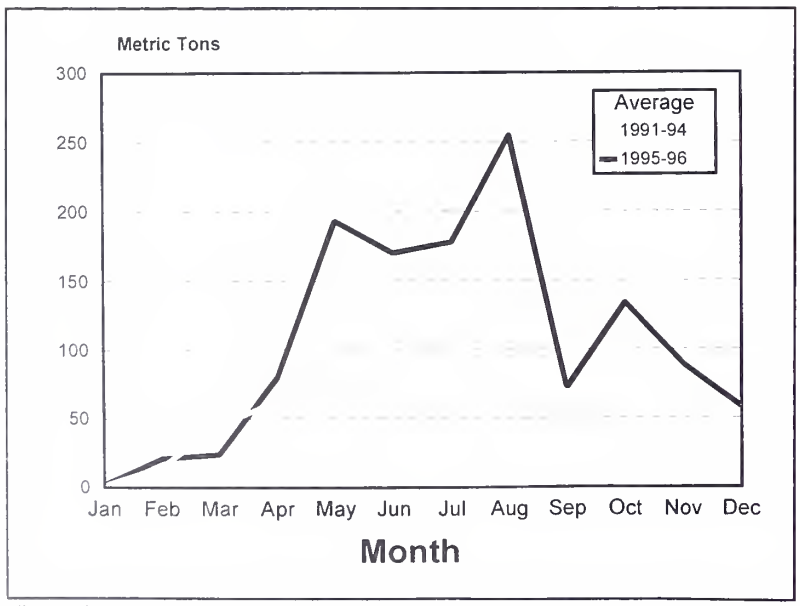

Figure 34.--The commercial fishermen outside Chile's 200-mile zone are reporting substantial catches during the second half of the year.

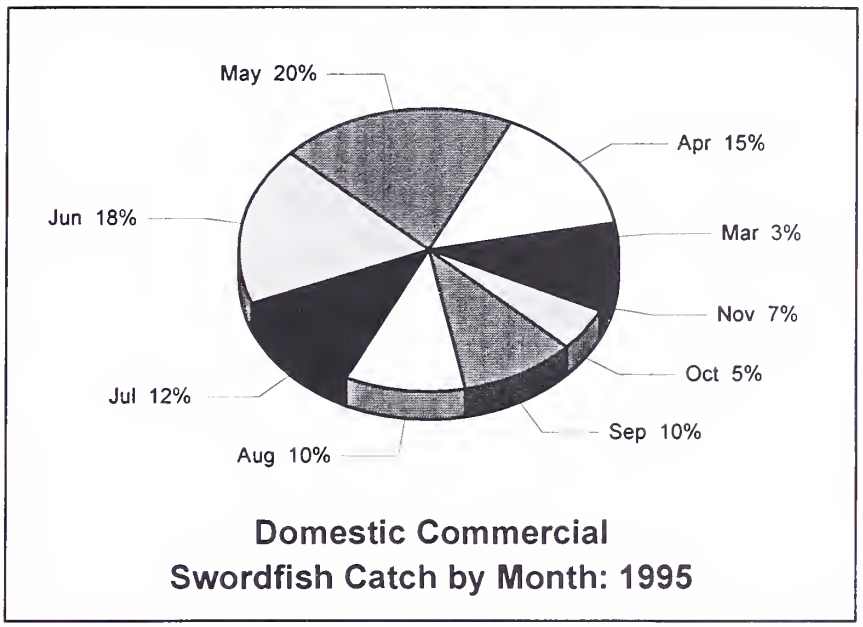

Figure 35.--The commercial fishery within the 200-mile zone during 1996 was mostly taken from April until June.

Several authors report that the size of the fish taken by Chilean fishermen is also somewhat seasonal. Researchers vary on the seasonality of size counts and some have begun to reassess previous conclusions. Various reports indicate that the largest fish are taken early in the season (appendices B5c2 and B5g5 and figures 37-39), primarily off the more southerly areas of the central coast.[179] Artisanal driftnet fishing during these early months of the season are concentrated along the southcentral coast. Very small quantities of swordfish, however, are taken in the early months of the year (appendix E3a1 and figure 20). One study reported larger trunk sizes off the southcentral coast (Regions VII and VIII) during 1988-90 early in the season--January and February (appendix B5g5 and figure 39). A more recent IFOP study during 1994-95, however, does not confirm the pattern of larger trunks caught early in the season off the southcentral coast (appendix B5g3). IFOP researchers report, as a result, that they have been unable to confirm anecdotal and previous statistical reports that the larger fish are taken in the south at the beginning of the season.[180]

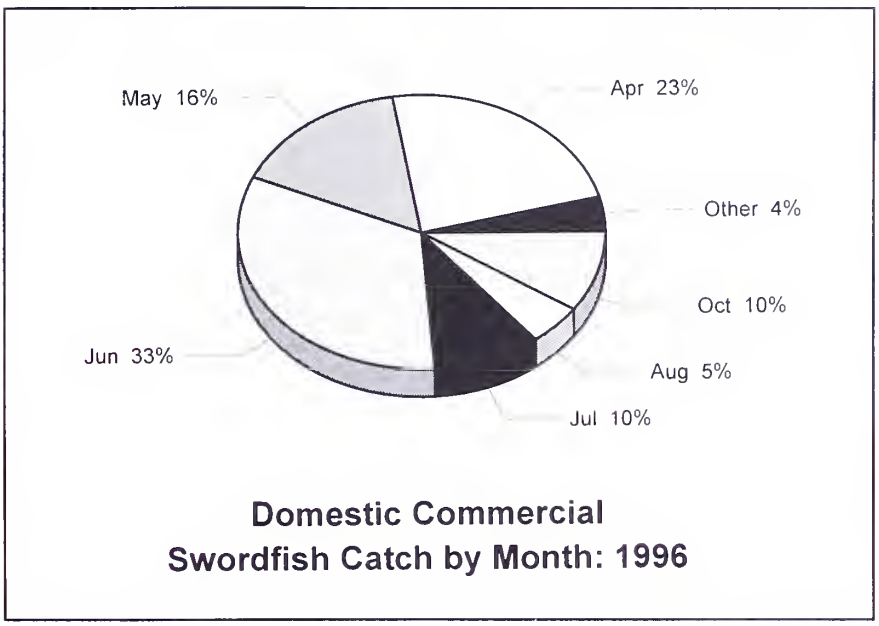

Figure 36.--Chilean commercial fishermen on grounds outside the 200-mile zone during 1996 reported most of their catch from May to August.

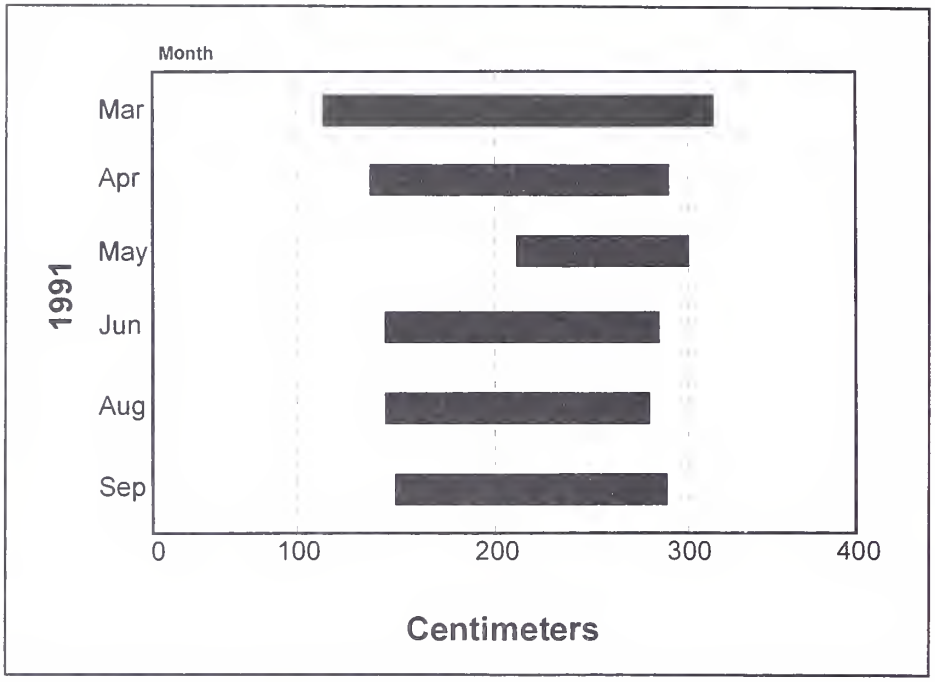

Figure 37.--Some artisanal data shows that there is a slight tendency to take somewhat larger fish at the beginning of the season.

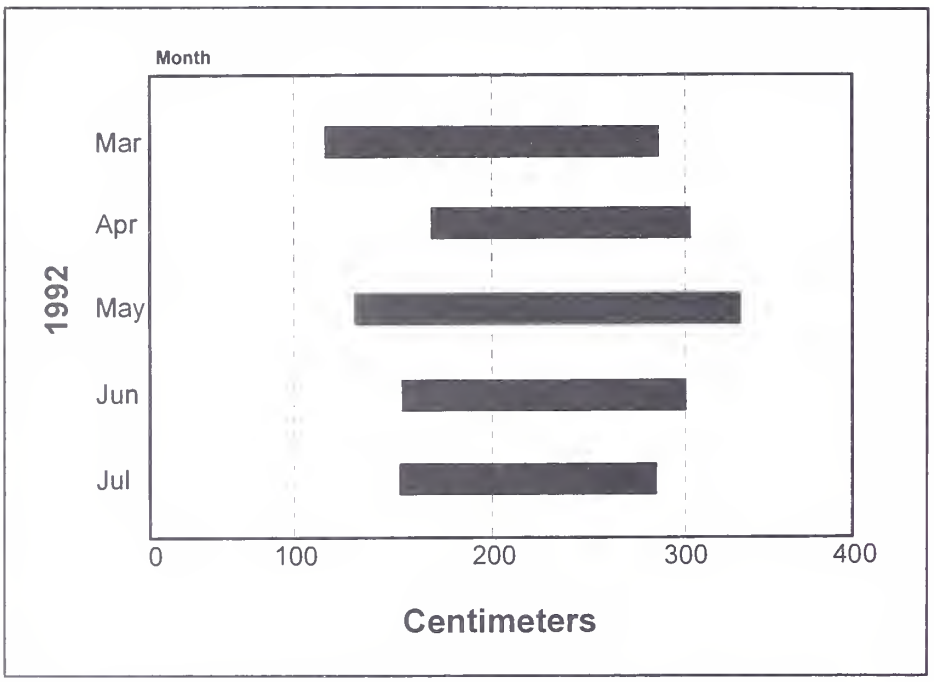

Figure 38.--Other artisanal data shows no clear pattern as to when the larger fish are taken.

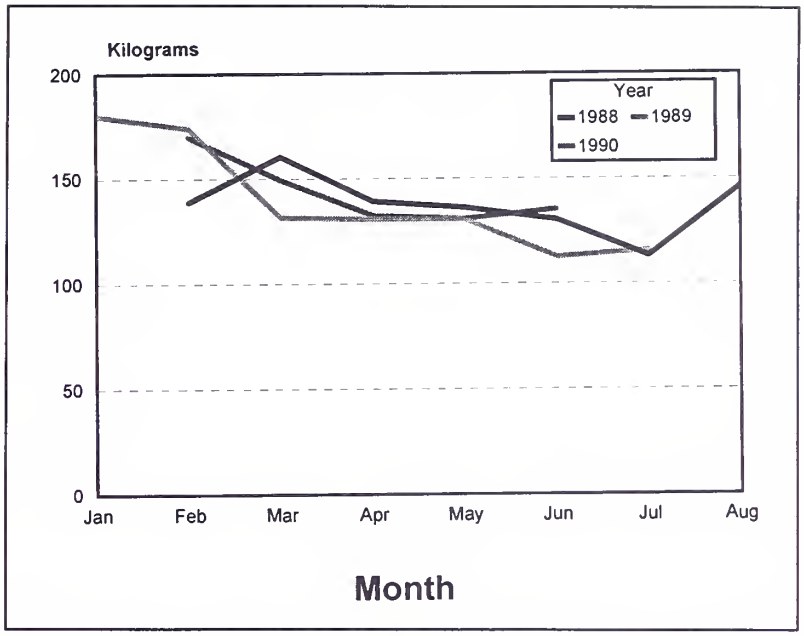

Figure 39.--San Antonio processing plants report a decline in sizes as the season progresses. This could reflect the varying importance of longline catches.

2. Foreign fishery

The Japanese have reported the most significant swordfish catches in the eastern Pacific and their longline data provide some insight on possible seasonal fluctuations. The Pacific patterns reported by the Japanese and other foreign fishermen, however, are complex and highly variable. In addition, there are substantial differences between available data sets. The fact that swordfish was not the target species further compromises the data, especially in assessing seasonality. The Japanese have primarily targeted tropical latitudes because of their focus on bigeye tuna, thus only limited data is available on swordfish for wide stretches of the southeastern Pacific south of 20°S.[181] The more limited effort at oceanic latitudes off Chile thus offers little insight on possible seasonal patterns.[182] The foreign data relatively close to the coast (75-100°W) suggests a much more seasonal fishery than that reported at tropical latitudes. This confirms the pattern shown by Chilean data.

Japanese yield data: Historic Japanese yield data (1952-85) show considerable fluctuations off southern Peru and Chile--mostly during the middle of the year from May through October (Ecuador, figure 7). Good yields were reported as far south as 40°S during May. The fishery then appears to move north away from the Chilean coast by November and reach minimal levels by January. The seasonal pattern in oceanic areas off Chile shows some the most extensive fishing from September through November (Peru, figure 10 and Ecuador, figure 7).[183] This roughly corresponds to the Chilean coastal catch data showing coastal catches declining during this period. The Japanese have reported good historical yields (1952-85) on the fringes of the Chilean 200-mile zone beginning in April and more prominently in May (figure 11). This continued through October when fishing in offshore areas begins in earnest lasting through November off central Chile (35°S) (Ecuador, figure 11). Fishing continued in oceanic areas during December and January, but somewhat to the north (north of 20°S). Oceanic fishing continued from February through March, but it is much less successful and more scattered (figure 12).[184]

Foreign catch data: Foreign longline catch data (primarily Japanese) compiled by FAO for 1991-93 also show a highly seasonal pattern. One assessment of 1991-93 catches shows catches outside the 200-mile limit (east of 80°W) off central Chile (30°-35°S) during the first quarter and further north along the northcentral and northern coast (north of 30°S) during the second quarter. This corresponds to the pattern reported by Chilean fishermen. The foreign catch data, however, provides insights on oceanic seasonal patterns which are not available from the coastal Chilean data. Swordfish appear to also display a strong seasonal pattern in oceanic areas at latitudes off Chile. Off the coast the fish are most prevalent during the third quarter (80°-95°W) and further west primarily during the fourth quarter (95°-150°W). There is some scattered evidence that the fish may then turn south and head east during the first quarter (160-130°S)[185] The evidence to support season fluctuations south of 25°S in the southeastern Pacific is very weak because of limited Japanese fishing at these latitudes.

G. Feeding behavior

Swordfish primarily feed at night. The fish off Chile tend to descend at sunset and feed during the night, returning to warmer surface waters at sunrise. They are often found off Chile feeding along the boundaries of the northerly flowing Humboldt Current where prey is particularly abundant. (See "Fishing Grounds.")

Very limited information exists on swordfish prey items.[186] Squid appears to be an important prey item, although there does not appear to be an important squid resource off Chile. Jack mackerel ("jurel") also appears to be an important prey item in coastal waters and there is a huge resource off Chile (photo 28). Other prey species include various other finfish, especially horse mackerel, and crustaceans (appendix B2a and figure 40).[187]

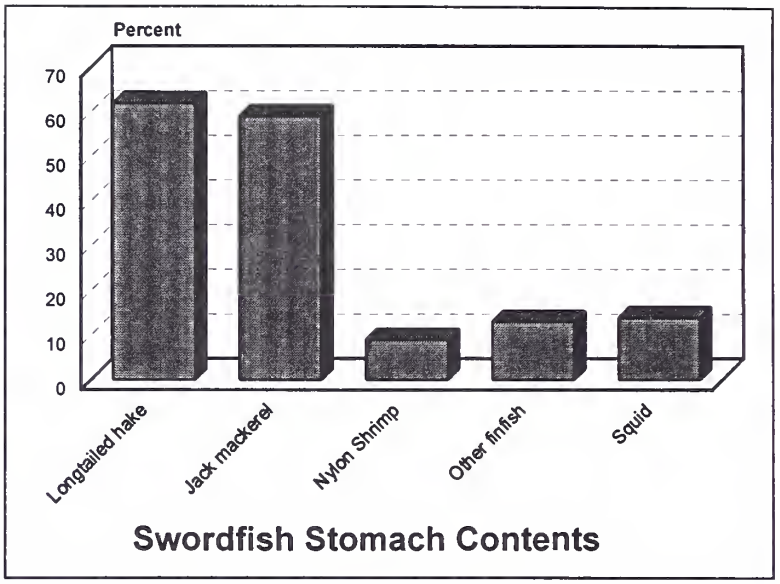

Figure 40.--One study of artisanal (coastal) catches shows swordfish feeding on hake and jack mackerel.

Photo 28.--The bulk of the massive jack mackerel catch is reduced to fishmeal. Dennis Weidner.

Squid: Sport fishermen in the 1950s reported squid as a major prey item.[188] Swordfish in many areas show a preference for squid. Squid is a preferred prey item for swordfish around the word. One assessment of swordfish feeding off Chile reported that squid was present in the stomach contents, but that finfish were more important in coastal waters (appendix B2a).[189] Another observer reports finding some squid in the stomach of fish taken by the artisanal fishermen along the central coast.[190] Reports from fishermen operating in offshore waters of Chile and Peru (19°S) report finding squid was the major prey item but that horse mackerel is also important.[191] Squid does not, however, appear to be a major resource off Chile. Chile's entire squid ("calamar" and "jibia") catch in 1996, for example, was only 26 tons.[192] The authors note that the abundance of squid off Chile is highly irregular. The giant squid (*Dosidicus gigas*) which swordfish is known to have fed on is sometimes found for a few months in commercial quantities off Chile and then disappears.[193]

Jack mackerel: Chilean researchers report that jack mackerel/"jurel" (*Trachurus murphyi*) is a primary prey item in coastal waters (appendix B2a and photo 28).[194] Swordfish yields appear to be affected by water temperatures and jack mackerel migrations.[195] One observer believes that the larger swordfish in particular may prefer jack mackerel.[196] A Chilean researcher points out that larger jack mackerel may approach closer to the Chilean coast after spawning than juveniles. This occurs both off the northern and central

coast.[197] Such a movement could explain the appearance of large females in coastal water and vulnerability to the artisanal harpoon and driftnet fisheries. There is an enormous jack mackerel resource off Chile and Peru.[198] The 4.4 million t Chilean catch of this species in 1995 is a larger catch than most country's report for their entire fishing industry. Chilean fishermen have significantly expanded their jack mackerel fishery in recent years and currently dominate catches in the eastern Pacific (appendix B2d and figure 41). It is primarily used as raw material to supply the country's massive fishmeal industry. (See "Fishing Industry Overview.") The jack mackerel fishing season currently peaks in the Fall and Summer (March-July/August) (appendix B2b and figure 42). The fishery is currently conducted along the central coast from ports located in Region V (especially San Antonio) and Region VIII (especially the Talcahuano area) (appendices E2e1 and B2c and figure 43).[199] Chilean researchers have compiled considerable data on jack mackerel populations, distribution, and migrations in recent years.[200] There have been considerable fluctuations in the size of the jack mackerel resource and some authors report a gradual expansion of the resource since the 1970s.[201] The peak jack mackerel fishing season appears to correspond to the peak swordfish season and primary fishing grounds (appendices E3a1 and E3b1 and figure 43). Jack mackerel are found along most of South America's Pacific coast from Ecuador to southern Chile (figure 44). Eggs and larvae can be found at southerly latitudes well out into the Pacific. Some authors have described a transoceanic distribution of jack mackerel along the Subtropical Convergence.[202] Chilean researchers report that jack mackerel follows a migration circuit which Soviet researchers referred to as the jack mackerel belt ("cinturón de jurel"). The Chilean researchers describe it as more of a narrow strip ("franja") in which the fish move up and down the strip from central Chile to central Peru. Jack mackerel off Peru's northern coat appears to be a separate stock.[203] Jack mackerel approach the Chilean coast at about 40°S following the prevailing currents. They enter the Humboldt Current and move north as far as northern Chile and southern Peru. Then they move west offshore to spawn. Finally they move south before turning east again toward the Chilean coast at about 40°S to complete the circuit.[204] This is somewhat similar to the seasonal and regional pattern observed above for swordfish. Other Chilean researchers believe the adult jack mackerel sub-population may be more localized.[205]

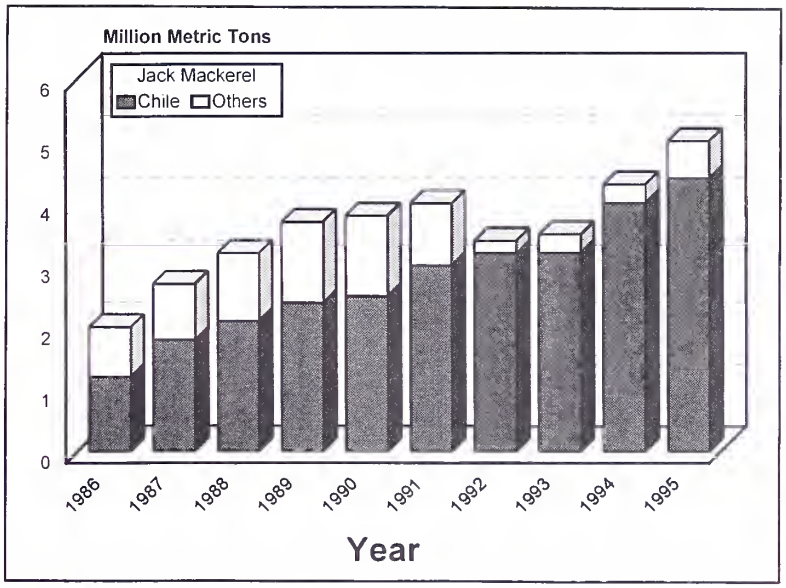

Figure 41.--Chile has massively expanded the jack mackerel fishery. This could be affecting swordfish catches in coastal waters.

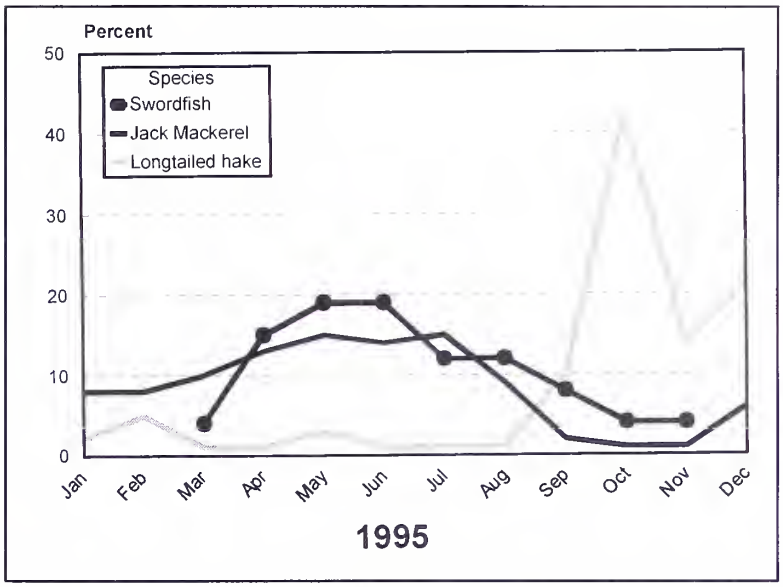

Figure 42.--The seasonality of swordfish and jack mackerel fisheries are quite similar.

Horse mackerel: Anecdotal reports indicate that swordfish off Chile and Peru feed on horse mackerel or "caballa" (*Scomber japonicus peruanus*). A fisherman operating off southern Peru near the Chilean frontier (19°S) reports finding some horse mackerel as part of the stomach contents, but was much less important than squid.[206]

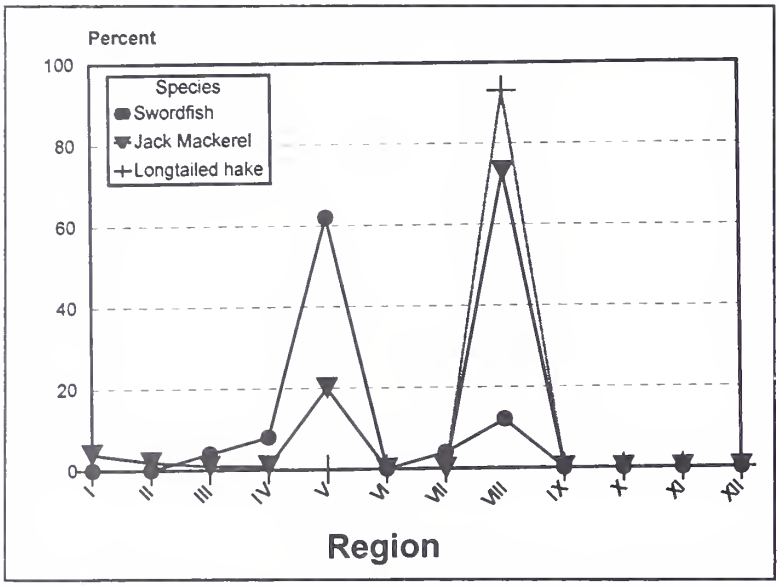

Figure 43.--Swordfish, jack mackerel, and longtailed hake are landed in the same regions. Hake and swordfish are taken seasonally by the same fishermen.

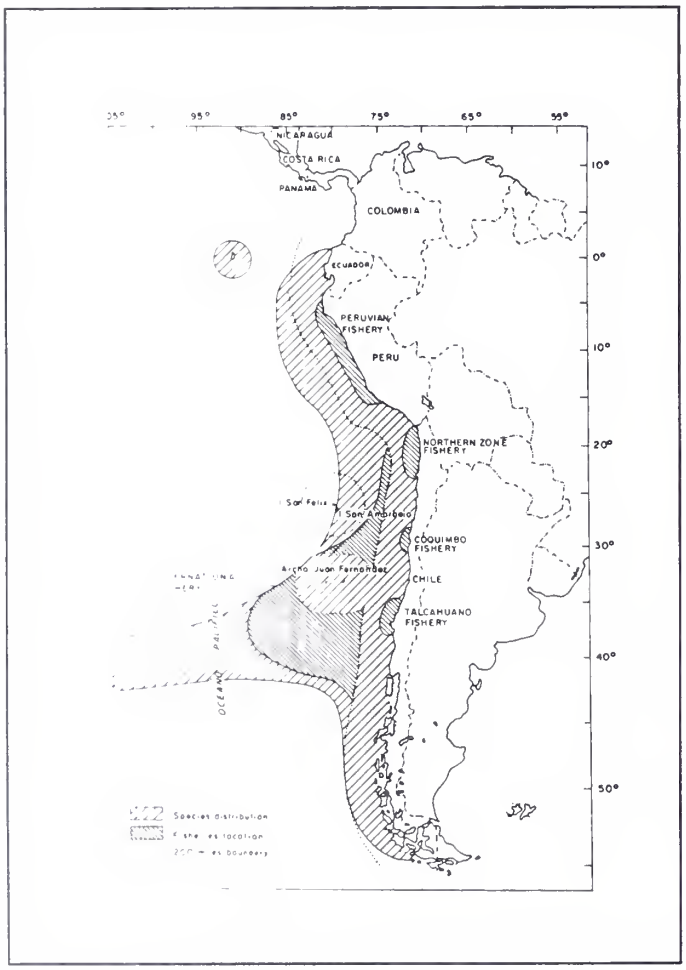

Figure 44.--Distribution of jack mackerel and location of main fishing areas in the southeast Pacific. Rodolfo Serra.

Longtailed hake: Longtailed hake or "merluza de cola" (*Macruronus magellanicus*) may be another important prey item, although the resource is much more limited. One swordfish stomach content study in c oastal waters suggests that longtailed hake is the most important fodder species (appendix B2a and figure 40), but given the much larger size of the jack mackerel resource, such a conclusion requires additional investigation. Unlike the jack mackerel fishing pattern, the seasonal pattern for longtailed hake is quite different than that of swordfish (appendix B2b and figure 42).

Other species: Swordfish are known to consume a wide range of species, including many species of finfish. One observer reports sardines as a prey item.[207] Swordfish may also consume small quantities of crustaceans (appendix B2a and figure 40). The specific prey species targeted varies by size and immature swordfish may have significantly different feeding habits.

Fishermen vary on the most effective bait. Recreational fishermen reported using a variety of species, including squid and bonito.[208] One respected recreational fisherman posed the question of why swordfish strike baited hooks near the surface if they feed at night in deep water. He speculates that the fish may be hungry, the bait annoys or arouses its curiosity, or the fish is simply enticed by an easy snack between meals.[209] Commercial longline fishermen use various baits, but squid and horse mackerel appear to be the most common.[210]

There are no studies comparing the prey preferences of different size swordfish.[211] IFOP researchers note, however, that existing data suggesting the importance of jack mackerel and long-tailed hake was stomach content data collected from the artisanal fishery which means mostly larger females (trunks of 100-150 kg).[212]

The feeding behavior may explain why it is that the larger fish are taken relatively close to the coast. One Chilean researcher reports that the larger fish (mostly females) are best suited to successfully feed on the jack mackerel which seasonally are more common in coastal waters than in oceanic waters. (See: "Species: Migrations") Coastal waters off Chile are cooler than surrounding oceanic water because of the

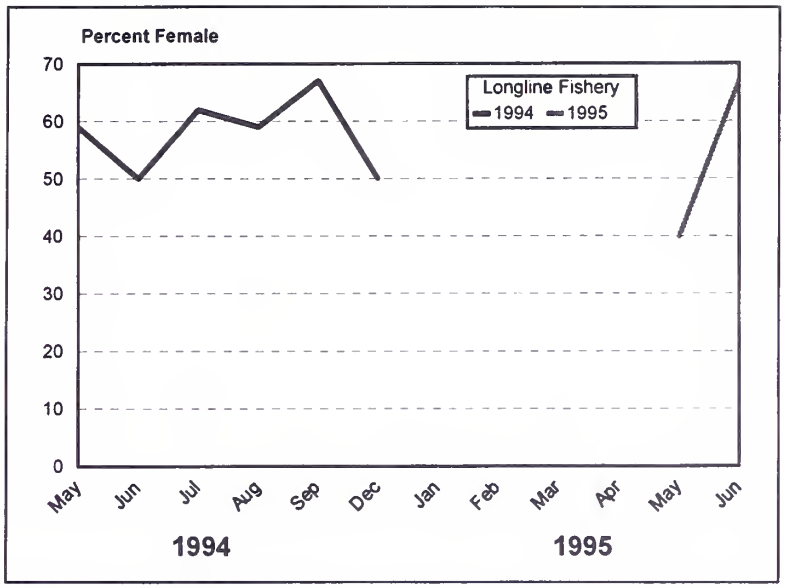

Figure 45.--Longline fishermen take somewhat larger quantities of females. The driftnet fishermen take much larger quantities of females.

Humboldt Current. (See: "Fishing Grounds.") As a result, the larger fish (mostly females) may be drawn into coastal waters because of a greater ability to feed in the colder water.[213] The greater bulk and strength of the larger fish would give them more endurance in colder water than smaller fish. The greater strength may also enable larger fish to lead migratory movements. Assessments confirm that there is a much greater percentage of females taken in the driftnet than the longline fishery (appendix B1a and figure 45).[214] This means that a greater proportion of females are being taken along the coast because the driftnet fishery is primarily conducted in coastal waters.

While Chilean researchers have begun to describe prey along the coast, little is known about feeding habits at offshore latitudes off Chile. Swordfish are believed to be capable of varying their diet seasonally.[215] Thus fish feeding on jack mackerel could target other species as they move into more oceanic waters. Fishermen report that fish appear to feed on different species in oceanic water. One longline fishermen reports finding primarily squid and to a lesser extent horse mackerel in the stomachs.[216] It is also unknown how feeding habits are affected by spawning. Some researchers have reported that the fish continue to feed while spawning. One researcher reports that observers aboard vessels off Venezuela found prey items in the stomachs of most spawning females, although it is not know if the stomachs were full or not. He also believes that the energy involved in spawning would seem to require the fish to feed constantly.[217] Little is known, however, about the food web in the sub-tropical and tropical areas where the fish spawn.

H. Spotting techniques

1. Temperatures

Sea-surface-temperature (sst) readings are one of the primary environmental conditions used by the fishermen to locate swordfish. (See "Fishing Gear and Methods"). The fishermen use satellite imagery to locate the temperature conditions in which the fish are most likely to be found (photo 29). (See: "Species: Temperature" and "Research.") Following jack mackerel concentrations and movements as well as locating temperature gradients in the water have proven highly beneficial to the fishermen.[218] Artisanal and commercial fishermen reportedly seek somewhat different water temperatures. One Chilean researcher indicates that the artisanal fishermen generally look for water about 16-17°C while the commercial longliners generally fish at 18-19°C.[219] Another report

Photo 29.--Even artisanal fishermen have equipped their vessels with temperature sensors to help locate swordfish. Dennis Weidner.

indicates that commercial longlining off southern Peru close to the Chilean marine border in water at 20-23°C.[220] The artisanal fishermen probably report lower water temperatures because they generally deploy their driftnets in the inshore areas most affected by the colder upwelled water and the Humboldt Current. (See "Fishing Grounds.") The commercial fishermen operate in the offshore areas where the water is warmer.

2. Water color

Chilean fishermen have noted a relationship between the color of the water and swordfish catches. Color differences were used by artisanal harpoon fishermen as early as the 1930s, and probably before, to help locate potential fishing grounds. They continue to be used by current artisanal and commercial fishermen. These color shifts appear to occur in areas where the cold Humboldt Current mixes with warmer oceanic water. Water temperatures vary seasonally. One researcher reports that the Humboldt Current is about 11-13°C and dark green. Another observer describes it as dark brown. Oceanic water is more bluish and often 15-16°C. In between the Humboldt Current and the open ocean is an area of mixing which tends to have a whitish ("lechosa") color. Swordfish can reportedly often be found in this mixing area.[221]

Researchers are unsure how to explain the relationship between water color and swordfish. The Humboldt Current is biologically rich, supporting a large population of phytoplaknton and the small fish which feed on the plankton. (See "Fishing Grounds.") The larger predators like swordfish are apparently drawn to feed on the smaller predators, such as hakes, squid, and jack mackerel.[222] It may be difficult to feed in the Humboldt Current itself because the water is so murky that swordfish can not visually identify prey items.[223]

The water colors in which the largest concentrations of fish can be found appears to change seasonally. IFOP reports that during the summer (January-March), the best catches are taken in celeste (light blue) colored water. During Fall (April-May), the best catches are taken in more greenish water (appendix B4).[224]

3. Other

Fishermen use a variety of other techniques to help locate swordfish. The actions of sea birds which can be spotted at some distance are one helpful indicator. One fishermen reports that where there are birds, there are usually swordfish. The fish may betray their presence by a distinctive odor, a fishy or briny smell. Dead or stunned prey items floating on the surface may also mean swordfish are present. Other signs are regurgitated stomach contents or oily defecation patches from which the distinctive odor originates.[225]

I. Year classes

Chilean researchers coordinated by IFOP are collecting data needed for age determination so that the population structure can be assessed. Such information is needed to provide a basis for sound management decisions. (See "Government Agencies and Policy.") The stock structure of swordfish is still not fully understood. (See "Species: Stock structure.") IFOP has, however, collected substantial data which is helping to better understand the stock structure of swordfish in the southeastern Pacific.

The fishery is currently targeting a wide range of year classes, including the younger year classes.
1994-95: One 1994-95 study indicates that fish from 1-15 years are currently taken in the fishery, but most of the catch (over 65-70 percent in terms of individuals) is made up of 2-6 year old fish (appendices B5d and B6a and figure 46).[226] The two principal

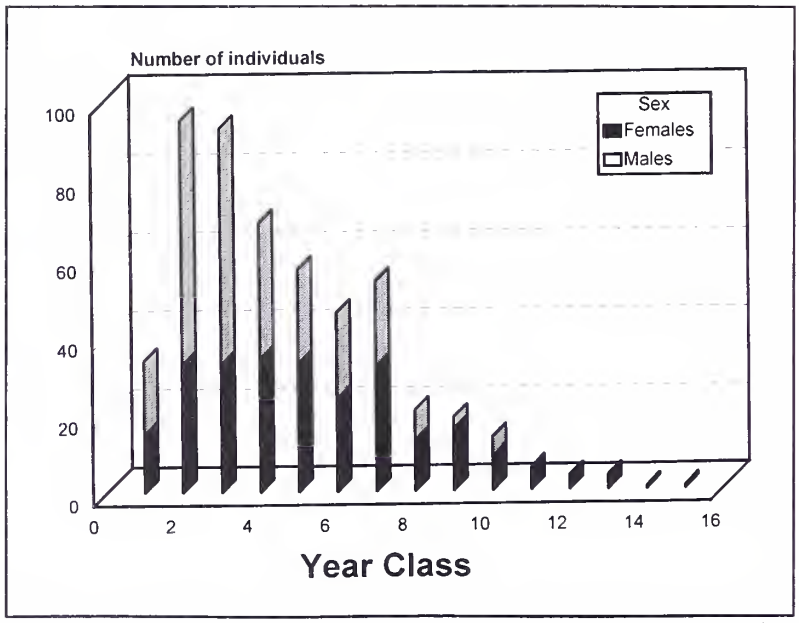

Figure 46.--A substantial part of the catch is composed of fish 3 years and younger and the great bulk of the catch is 7 years or less.

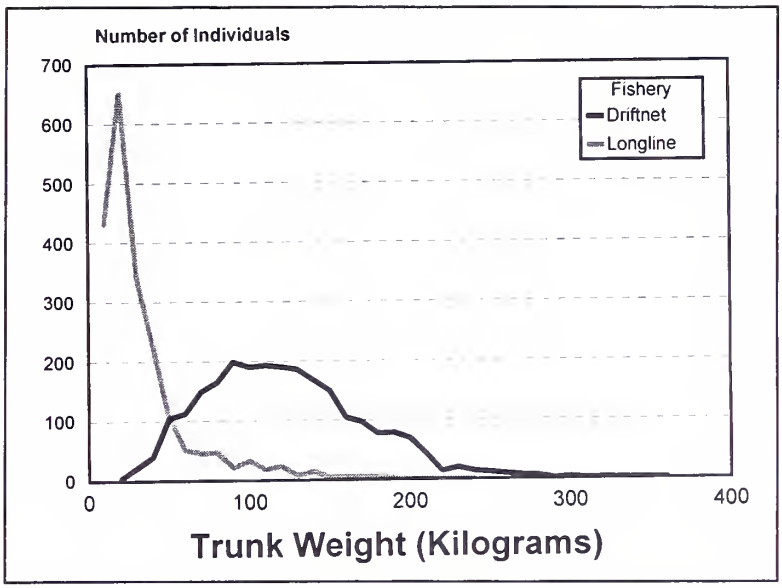

Figure 47.--Driftnet fishermen take much larger swordfish than the longline fishermen.

Chilean swordfish fisheries focus on sharply different year classes. The commercial longline fishermen report a much higher catch of younger fish than the artisanal driftnet fishermen (appendix B5g1-3 and figure 47). Most of the larger fish, primarily females, are taken by the driftnet fishermen.[227]

1995-96: A follow-up study in 1995-96 found that the catch included females from 1-15 years and males from 1-12 years. The greatest numbers were females (3-6 years) and males (4-5 years). The overall catches were composed of fish 4 years or younger (35 percent), and 5 years or younger (51 percent).[228]

Chilean fishermen are increasingly targeting younger fish. Chilean biologists confirm this trend.[229] There has been a steady decline in the size of the fish taken (appendix B5h1 and figure 48). IFOP studies conducted in 1994-95 suggest that nearly 40 percent of the catch (individuals) had shifted to 1-3 year old fish (appendix B6a). SSP officials are very concerned about the declining size.[230] The trends in both the driftnet and longline fishery are not encouraging and were a major factor in the 1997 SSP decision to set minimum sizes.

Sexual maturity: Studies by foreign researchers suggest substantial numbers of female swordfish are sexualy mature by the time they reach 200 cm LJFL.[231]

Sizes: Chilean researchers differ somewhat on the sizes of the fish currently being landed. A conservative estimate using one Chilean size study, suggests that almost all of the 1-3 year fish are sexually immature. A few sexually mature fish appear at 4-5 years and a substantial portion of the 6-7 year fish are mature. Most fish 8 years and older are mature (appendix B5d and figure 46).[232] One recent Chilean study found that fish begin to mature at about 5 years (188 cm-LMIH) which would be females of about 60-70 kilograms. All of the fish sampled were found to be sexually mature at 220 centimeters.[233] While there may be some regional variability, it is unlikely that swordfish in the southeastern Pacific have a greatly different maturation pattern. It thus appears that Chilean fishermen overall are taking very substantial quantities of sexually immature fish.

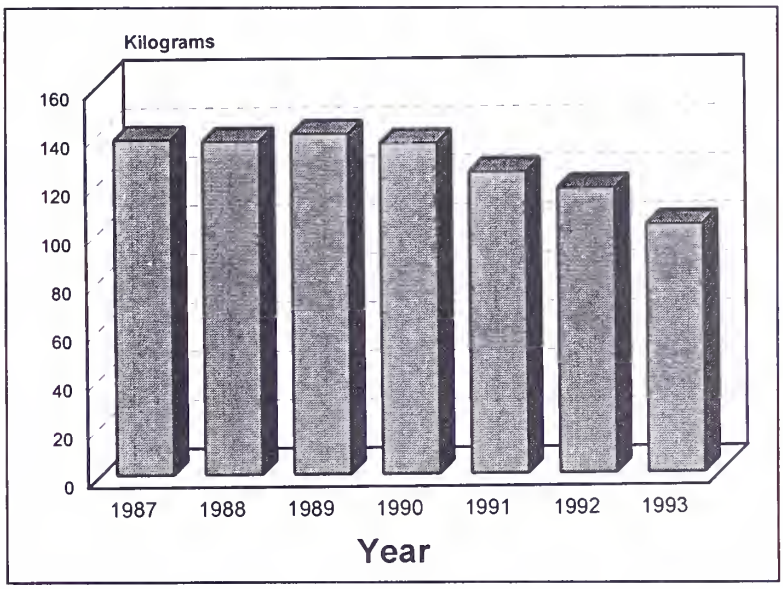

Figure 48.--Artisanal fisherman are reporting a steady decline in swordfish sizes.

The pattern is significantly different in the two principal Chilean fisheries:

Driftnet: Driftnet fishermen have taken relatively large fish, but in recent years there appears to have been a significant shift in the year classes taken. IFOP has reported on the length and weight of driftnet landings, often by port, in various years (appendices B5c1, B5e and f, B5g1-6, and F1 and figure 49). An assessment of the trend is complicated because the authors do not have a complete set of the IFOP and other Chilean studies assessing size trends. In addition there appear to be substantial variations between studies. The studies available to the authors correlating length and weight to age (appendices B6b-c) show that the average size of the fish

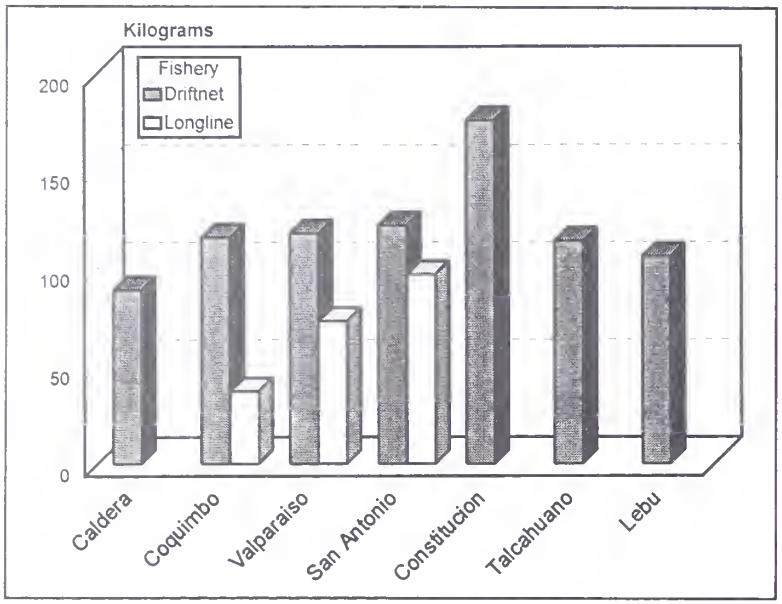

Figure 49.--Longline fishermen report landing very small fish at Coquimbo which is the most northerly port from which large numbers of longliners operate.

harvested by the driftnet fishermen appears to have declined substantially.[234] One study based on 1987-88 landings, as the fishery was expanding, indicated that the driftnet fishermen were taking mostly 6-8 year old fish (B5b1-2, B5g2, and B6b-c). A study at the peak of the fishery during 1991-92 reported that the fishermen were taking large quantities of small fish from much younger year classes, averaging about 5-6 years (appendices B5g1 and B6b and figure 47). After the 1991 peak the driftnet fishermen reported taking even smaller and younger fish. The fishermen by 1994-95 were taking small fish averaging only about 5 years old (appendices B5g3 and B6c).[235] This apparent shift of about 2 years in the year class harvested is potentially significant. The catches during the 1980s appear to have been mostly sexually mature fish. If the driftnet catch is now largely 5-year old fish, this means that most of the catch is now composed of fish which have not matured and reproduced. This has been critical for the Chilean fishery because the driftnet landings through 1995 constituted the bulk of the catch. While the data available to the authors is not adequate to draw firm conclusions, it certainly suggests a potentially adverse trend that may reflect a serious problem. IFOP is collecting more complete data and will be able to reach more precise conclusions. IFOP researchers caution that the apparent significant size decline is due to the artisanal fishermen shifting to more distant grounds where smaller fish are taken, thus showing a significant size decline. Thus the size of the fish in the traditional inshore coastal waters, however, may have declined only slightly.[236]

Longline: The commercial longline fishermen take mostly small, juvenile fish. The authors have no time-line data on the commercial fishery, but 1994-95 size data show that the longline fishermen in 1994-95 were taking fish with trunks mostly from 33-75 kg averaging 40 kilograms. Some fish, however were as small as 17 kg (appendix B5g3). This focus on fish from 2-4/5 years old would mean fish averaging about 2.5 years. Some fish were being taken as young as 1 year (appendix B6c). This is significant because it means that the great bulk of the longline catch is juveniles (appendix B5g1 and figure 47). The longline fishermen are clearly removing large numbers of juvenile fish before they can spawn. Chilean specialists have expressed concern over this large take of small swordfish.[237]

Harpoon: The harpoon fishery has declined to very small quantities and thus data from the fishery is now not critical for management decisions. Some available size data from 1987-88 suggests that relatively older, mature fish averaging about 9 years were being taken by the harpoon fishermen (appendices B5g2 and B6c). No current size data is available to the authors. While varying substantially from year to year, the harpoon fishermen appear to target larger fish, meaning older year classes than the driftnet fishermen (appendix B5g2). Harpooning in theory is the most selective fishing method because the fishermen assess individual fish.[238]

J. Sex differences

Foreign researchers have found that female swordfish live longer and reach larger sizes than male fish. Data collected by Chilean researchers in their local fishery confirm this tendency. One IFOP sampling study in 1994-95 found that a larger proportion of the older fish taken were females. Fishermen take females as old as 15, but the oldest male was only 11 years old. Older males were quite rare, less than 8 percent of the sampled males were 7 years old or older (appendix B5d and figure 46). More than 33 percent of the females taken were 7 years or older. Not only is the catch of older fish predominately female, but within year classes, females tend to be larger (appendix B5d).[239] This sexual dimorphism is common among billfish and is probably explained by the species' reproductive strategy. The strategy employed by swordfish, other billfish, and tunas is to produce massive numbers of eggs. Such

production necessitates a great expenditure of effort, probably explaining the large female body sizes.

The overall Chilean swordfish fishery, both driftnet and longline, appears to be harvesting a substantially larger numbers of females than males. The commercial longline fishery takes slightly more females than males, but the larger driftnet fishery, as well as the small harpoon fishery, take much larger numbers of females (appendices B1a-b and figure 45). IFOP researchers are unsure as to what is causing the differing sex ratios in the catches. Some preliminary data suggests that it may be due to the selectivity of the gear or availability on the grounds fished.[240] The larger size of the females, for example, may give rise to behavioral differences which make them more vulnerable to specific gear or operations on specific grounds. The available data, however, still represents a relatively small sample, so should be treated with caution.

Longline: Samples collected in the oceanic areas where longlines were deployed during 1994-95 show a somewhat erratic pattern, an even distribution (2 month), more males than females (1 month), but with females somewhat dominate in most other months (5 months) (appendix B1a and figure 45). This would appear to suggest that more females are taken in offshore areas where the longliners operate, but that the ratio of females to males is not great. Notably, longlines are the least selective gear employed (in terms of the sizes of fish taken) by the fishermen and the gear which has the lowest anomalies in sex ratios (appendix B1a).

Driftnets: The driftnets appear to be taking a much larger proportion of females, although the sample is relatively small (appendix B1a).[241] This is significant because the driftnet catch through 1995 constituted the bulk of the Chilean catch and trends with this gear determind overall trends in the fishery. Some data suggests that the larger take of females may reflect the selectivity of the gear for larger fish, although Chilean specialists stress that grounds may be a more important factor.[242] (See "Species: Size variations.") One Chilean researcher stresses that the selectivity of driftnets should not be overstated. He reports that substantial quantities of small fish are also taken in the driftnets and that the greater take of females is probably more of a reflection of the higher availability of females on coastal grounds where much of the driftnet catch is taken.[243]

Harpoon: The harpoon fishermen take much larger numbers of females (appendix B1b). This is presumably because the fishermen observe individual fish and, as a result, select the largest. It may also be a reflection of a greater availability of females on coastal grounds where the harpoon are utilized. Given the relatively small number of fish now taken with harpoons, the potential impact on the stock is limited.

The consequences of a fishery which harvests larger numbers of female than males is unclear. This is not, however, a pattern which is unique to Chile. Other countries managing swordfish fisheries do not restrict captures of females which would be basically impossible to accomplish because the fish can not be sexed until they are boated at which time most are dead. Countries managing swordfish commonly restrict the overall quantity caught and the take of small, juvenile fish.

Available artisanal catch data suggests some seasonal variation in the catch ratio of males and females, although again the sample is to small to draw firm conclusions. Data collected from central Chilean ports during 1989 indicated that both the harpoon and drift gillnet fisheries were taking primarily females during the first few months of the fishery (January through April) (appendix B1b). During the peak fishing season (May through July), however, the catch was approximately equal numbers of males and females.[244] It is unclear if this represents a behavioral difference in male and female fish or perhaps more importantly a difference between larger and smaller fish. One possibility, for example, is that the larger fish (mostly females) are stronger swimmers and therefore arrive earlier off Chile than the smaller males.

K. Size variations

Swordfish size distribution off Chile appears to vary geographically, depending on the grounds fished--by both north/south latitudes and east/west longitudes off the coast. The Chileans have not yet completed a stock assessment to describe these variations, but some foreign research is available. The Chileans have, however, compiled a wealth of fishery-based data. Given the extensive effort deployed since 1986, the fishery data is probably a relatively accurate indicator of the actual distribution--at least for the sizes targeted.

The grounds fished are an important factor explaining the larger fish taken by the driftnets. Several Chilean researchers have told the authors that they believe that grounds are the primary factor.[245] Reports from the fishermen as well as the limited available catch data do show much larger fish being taken in coastal waters. The available data, however, must be used carefully as some of the apparent geographic differences may be due more to gear

selectivity rather than the grounds fished. Very substantial size differences are reported by fishermen as a result of different gear deployed. As the deployment of different gear varies by grounds, gear differences can show up as ground differences in the data or visa versa. One 1994-95 IFOP study appears to show that the grounds are less important than the gear (appendix B5g3), but the limited time period covered prevents drawing any sweeping conclusions. The apparent differences between grounds are much less clear when the selective impact of the gear used is considered. Some geographic trends, however, such as an abundance of small swordfish in the north are clearly evident.

1. Gear differences

The larger fish are taken in the driftnet and harpoon fisheries. This may be primarily a function of the selectivity of the gear. The driftnets and especially the harpoons are more selective gear (in terms of fish size) than longlines. The mesh size of the Chilean driftnets allow many small fish to pass through unharmed.[246] (See "Gear and Fleet Operations.") A large driftnet mesh size, for example, will reduce the catch of small swordfish. The baited hooks on the longlines are much less selective, although the size of the hooks used by the commercial longliners prevent the taking of extremely small fish. Even so, several Chilean researchers are convinced that grounds are a more important factor than gear selectivity. The data available to the authors comparing size distribution by grounds and gear is, however, limited and any conclusions drawn at this time should be considered highly tentative.

Driftnet: Chilean driftnet fishermen report taking much larger fish than the longline fishermen and available data confirms that the driftnet gear yields the larger fish.[247] One recent study confirmed that the driftnet-caught swordfish are substantially larger than the fish taken by longlines, finding that most of the driftnet-caught fish were from 80-200 kg, but that most of the longline catch was less than 60 kg (appendix B5g1 and figure 47). Another study indicated that the fish taken by driftnets in 1994-95 reportedly averaged nearly 115 kg (trunks) (appendix B5g3).[248] This was nearly three times larger than the longline-caught fish averaging only about 40 kg (appendix B5g3).[249] Overall catch data is not, however, a clear indicator of relative gear selection because it could represent the varying geographic availability of different sized fish. Chilean observers report that driftnet vessels operate closer to the coast than the longliners which are restricted to offshore grounds. Thus size differences could be due to the different grounds on which the gears are deployed, rather than the selectivity of the gear. (See "Longline" below.) There is some reason to believe, however, that the primary reason for the different sizes taken by driftnets and longlines is the greater selectivity of the driftnets. Both longliners and driftnet vessels operate extensively in only one common area, the central oceanic area (Zone 3), and operations in that area appear to confirm the greater selectivity of the driftnets. The driftnet fishermen took much larger fish (122 kg trunks in 1994-95) than the longliners (75 kg trunks) in that commonly fished area (appendix B5g3).[250] Chilean researchers stress, however, that the selectivity of the driftnets should not be over emphasized and that some small swordfish are taken in the nets.[251] In addition, the 1994-95 data has some weaknesses that may have affected results.[252] The driftnets deployed in Chile catch smaller swordfish than taken with harpoons (appendix B5g2).

Harpoon: Harpoon fishermen operate even closer to the coast than the driftnet fishermen. There is virtually no directed harpoon fishing at present. Artisanal fishermen still operate small bongos and faluchos with very limited range, but only a few are deployed for swordfish (photo 52). In many cases fishing is a part-time activity. They fish for a variety of species which may seasonally include swordfish (See: "Vessels.") Most of the harpoon catch, however, is now taken opportunistically by the driftnet fishermen who have installed "tangones" on their boats. Available data from Valparaíso landings suggest that the harpoon fishermen catch the largest fish (appendix B5g2).[253] This is presumably because each fish is individually selected. Other observers believe that the larger fish are found close to the coast and this may also partially explain the large fish taken with harpoons.

Longlines: Size frequency data available for 1994-95 show that the Chilean longline fleet is currently taking very small fish (appendix B5g1 and figure 47). Most of the catch in the northern offshore area (Zone 1) was under 50 kg (trunk weight) and averaged only 33 kilograms. The 1994-95 longline catch in the central offshore area (Zone 3) was somewhat larger fish, but still averaged only 75 kg (appendix B5g1 and 3).[254] The fish taken by the longliners are much smaller than the fish taken by the driftnet vessels (appendix B5g3 and photo 30). (See: "Driftnet" above.) While the selectivity of the gear may be the primary factor, many Chilean specialists are convinced that the grounds fished may be of more importance.[255] That impact appears to be most pronounced off northern Chile (Zone 1). (See "Grounds" below.) The longliners operate extensively in the northern offshore coastal zone (Zone 1) where smaller fish are prevalent, partially explaining the large longline catch of small fish.[256] One Chilean researcher theorizes that the warmer water off the northern coast is the principal reason juveniles are more abundant there.[257]

Photo 30.--Commercial longliners tend to land much smaller swordfish than the artisanal driftnet fishermen. Dennis Weidner.

2. Ground differences

Chilean fishermen fish different grounds located both northern and central coasts as well as in coastal and offshore areas. The grounds appear to have considerable impact on the size of the fish harvested. The most notable difference is the larger number of small, juveniles taken on the northern grounds. Chilean fishermen also report taking larger fish along the southcentral coast early in the season, although available data shows a more mixed pattern (appendix B5g3). The authors stress that the trends described below should be used with caution, given the limited samples and varying time periods covered.

North/south: Chilean swordfish fishermen operate extensively from the northern to the central coast. The fishermen report taking the largest fish off the southcentral coast and the smallest fish off the northern coast. This pattern is confirmed by several industry observers.[258] Some data, however, does not confirm this pattern, but it does confirm that very small fish are taken in the north, especially on offshore grounds.

Southcentral/central: Some Chilean studies confirm that larger fish during 1988-90 were being landed in southcentral ports, Lebu and San Vicente (164-171 kg); than in the central, San Antonio and Valparaíso (100-129 kg); or northern, Caldera (76-106 kg) ports (appendix B5g4 and photo 31).[259] Other data available to the authors, however, suggest a more varied pattern. The IFOP 1994-95 study did not confirm the catch of larger fish along the southcentral coast. The study showed no notable regional variations in size frequency of driftnet catches taken along the southcentral coast (Zone 6) and central coast (Zone 4) or the central oceanic (Zone 3) fishing areas. The driftnet-caught fish in the central oceanic and coastal areas (Zone 3 and 4) averaged slightly over 120 kg (trunk weight) (appendix B5g3). The driftnet catch along the southcentral coast (Zone 6) were in fact somewhat smaller, less than 110 kilograms. Data available by port also do not show that large fish are being landed in the southcentral ports early in the season (appendix B5g6 and figure 49). Such discrepancies may be in part due to the limited data available and the varying months during which the data was collected in different studies.

Northern: The most notable conclusion flowing from the data collected in the Chilean fishery is the very small fish being taken by longliners in the northern oceanic area (Zone 1) (appendix B5g3).[260] Fishing companies confirm this pattern of small fish taken off the northern coast.[261] The fish taken by the longliners on the Nazca Ridge, for example, tend to be especially small.[262] All of these fish are taken by longliners. Foreign research has also confirmed the presence of small fish in the north. Experimental catches with longlines off Chile west of 120°W conducted with Japanese assistance during 1979 yielded relatively small fish, averaging about 170 centimeters (cm).[263] Conversion equations are available for comparing studies with differing measurements (appendices B5g1-2 and figure 47).[264]

Coastal/offshore: The relationship between the size of the fish and the distance from the coast in the Chilean fishery is unclear. The fishermen report substantial differences in the sizes landed, taking the larger fish along the coast. Most observers confirm that much larger fish are taken in coastal waters.[265] Actual studies comparing fishing areas are limited.[266] The most extensive assessment on fishing areas is the 1994-95 IFOP study. The authors stress that this data is based on only one study, collected during a limited time frame and for differing months each year. Thus while providing some potential insights, it should be used with caution.

Photo 31.--Artisanal fishermen at San Vincente like other Chilean ports have been landing increasingly smaller sized swordfish. Dennis Weidner

Artisanal/commercial comparisons: The IFOP data appears to show that the fish taken in these offshore zones, especially the northern oceanic zone (Zone 1), tend to be smaller than those taken along the coast. Fish taken offshore (Zones 1 and 3) averaged only 33-75 kg, compared to 88-121 kg in the coastal zones (Zones 2, 4, and 6) (appendix B5g3). The data, however, could reflect the selectivity of the gear more than the impact of the grounds fished, although some Chilean specialists are dubious about this conclusion.[267] The only area in which artisanal driftnets and commercial longlines are deployed in the same zone is the central offshore zone (Zone 3). In that zone the artisanal and commercial fishermen report substantial differences in the size of the fish taken. The artisanal fishermen using driftnets averaged trunks of 122 kg, much larger than the 75 kg averaged by the commercial fishermen using longlines. This suggests that the larger fish were being caught along the coast because of the greater selectivity of the gear rather than the greater availability of large fish along the coast. Chilean researchers note, however, that Zone 3 is covers a very large area and that artisanal and commercial fishermen target different sections of Zone 3.[268] This is not reflected in the data and would obviously affect the conclusions drawn.

Artisanal comparisons: Only limited coastal/offshore data is available from the artisanal driftnet fleet because they conduct mostly coastal operations. The limited data on artisanal fishermen operating in oceanic and coastal areas (Zone 3 and 4) show almost identically sized fish (121-122 kg) (appendix B5g3).[269] Using identical gear, the artisanal fishermen were observed to be taking the same sized fish, suggesting that larger fish are not more abundant along the coast. This is further evidence that the available data showing large differences between the sizes of fish taken from coastal and offshore grounds may be comparing gear instead of grounds.

Commercial comparisons: No comparative coastal/offshore data is available from the commercial fleet because they are not allowed to fish in coastal areas. Interestingly, the IFOP study indicated that artisanal fishermen reported that trunk sizes in the northern offshore grounds (Zone 1) were larger than along the northern coast (Zone 2), but this could have resulted from the very limited sample, especially in the northern offshore ground (appendix B5g3).[270]

L. Size decline

The world's largest swordfish and most of the larger swordfish have been taken off Chile. The world record, a 536-kg giant, was taken by sport fishermen with hook and line off northern Chile in 1953.[271] Substantial numbers of large swordfish were reported by sport fishermen during this period. In fact, with only a few exceptions, most of the large swordfish taken by anglers worldwide have been taken off Chile.[272] The artisanal harpoon fishermen landed even larger fish. One visiting American sport fishermen in the 1950s observed artisanal harpoon fishermen landing a huge 710-kg swordfish.[273] Almost certainly even larger fish had been landed given the limited number of days the American fisherman was in Chile.

Chilean fishermen appear to be taking increasingly smaller fish. Several Chilean observers have noted the declining sizes.[274] The authors have noted various anecdotal accounts suggesting that the size of the fish harvested has been declining. One SERNAP official reports that in the 1970s fish as large as 450 kg were reported, but that the average size landed by the

artisanal fishermen in San Antonio has declined significantly.[275] Several fishing and processing companies have also noted a declining size of the fish.[276] One processing company reports that swordfish in the 1980s averaged about 120 kg (dressed), but are now much smaller.[277] A series of Chilean reports provide size data. The available IFOP data, however, clearly show a trend of declining sizes (appendix B5 series). Data collected by IFOP from the major fishing ports indicates a steady decline in the size of the fish caught during the 1989-93 seasons.[278] Data from the artisanal fleet operating from San Antonio and Valparaíso show relatively unchanged sizes from 1987-90, but a major decline since 1990 (appendices B5h1-2 and figure 48). The average size in 1987 was 138 kg (trunk weight) and was still 136 kg in 1990, but declined to only 102 kg by 1993. Available size distribution data from the artisanal fleet shows a steady shift toward increasing numbers of small fish (figures 50-54).

Preparing trend lines with available data has proven difficult. Many of the available reports present the data in varying formats, making time-line trend assessments difficult. The authors, as a result, have been unable to compile detailed extended time-line data. The limited available data, however, does show a declining average size, especially after 1990.

A leading Chilean researcher warns that available size statistics should be used with caution. She reports that the size of swordfish caught in coastal waters has declined, but not significantly. The data showing size declines may be due to the growing range of the artisanal fleet. The artisanal fishermen in 1996 took their catch at increasing distances from the coast, and the catch declined sharply (appendix E2g and figure 64). (See "Grounds".) The fish they are taking in these offshore waters is smaller and thus the average size of the fish landed is declining. This does not mean that the size of the fish taken in the inshore waters is declining.[279]

The declining size of the fish landed would be an especially disturbing development. Falling sizes are a classic indicator of possible overfishing and declining stocks. Not only is the trend worrisome, but available data from both the longline and driftnet fishery suggests that much of the Chilean swordfish harvest is now composed of juveniles which have not yet reached sexual maturity and reproduced. Such a development has obvious serious implications for swordfish stocks in the southeastern Pacific and the Chilean swordfish fishery. (See "Species: Spawning" and "Species: Year classes.") The pattern varies in the different fisheries.
Harpoon fishery: The authors do not have time-line data to assess trends in the harpoon fishery, but given the small quantity of fish taken and the tendency to take larger fish, the harpoon fishery is now of only marginal importance to fishery managers.
Longline fishery: It is clear that the longline fishermen are currently taking very small fish. Anecdotal reports suggest that the commercial fishermen have taken small fish from the inception of the fishery. The authors, however, have very limited time-line data and cannot assess trends. Data available for 1992 show that more than half the catch were individuals 60 kg or less (appendix B5h2). About 80 percent of the longline catch in 1994-95 was fish smaller than 50 kg (appendices B5g1 and 3 and figure 47). It does appear, however, that foreign and domestic fishermen have reduced longline effort in the eastern Pacific through 1995. So the impact of longlining was declining. Whatever the trend, the small sized fish being taken by the longliners could still be having a serious impact on stocks. This is why countries which attempt to manage swordfish commonly restrict the catch of juvenile fish.[280] The declining longline trend, however, was reversed dramatically in 1996 when the commercial fishermen increased their catch nearly four times (appendix E2g and figure 64 and 65).
Driftnet fishery: The declining sizes taken in the artisanal driftnet fishery, which through 1995 accounted for most of the Chilean landings, has been especially disturbing. Current data suggests that substantial quantities of the driftnet catch is now juvenile fish. Even though fishing effort has declined in recent years, such a shift may have had a serious negative impact on yields and the status of the stock. (See "Species: Stock status.") The massive decline of the 1996 artisanal drift catch substantially reduced the effort on coastal grounds.

M. Effort

IFOP and cooperating universities have collected substantial data on fishing effort. The IFOP research effort is the most extensive investigation on swordfish currently underway in Latin America. (See "Research.") The fishing logbooks submitted by fishermen provide data on each trip, including departure date and return, base port, fishing area, and catch. Available fishing effort data, however, is primarily days at sea and thus factors such as longer distances, larger vessels, longer driftnets and longlines, and increasing expertise with the fishery are not addressed.[281] Despite the limitations, the available data does probably provide a good, all be it crude, estimation of Chilean fishing effort.

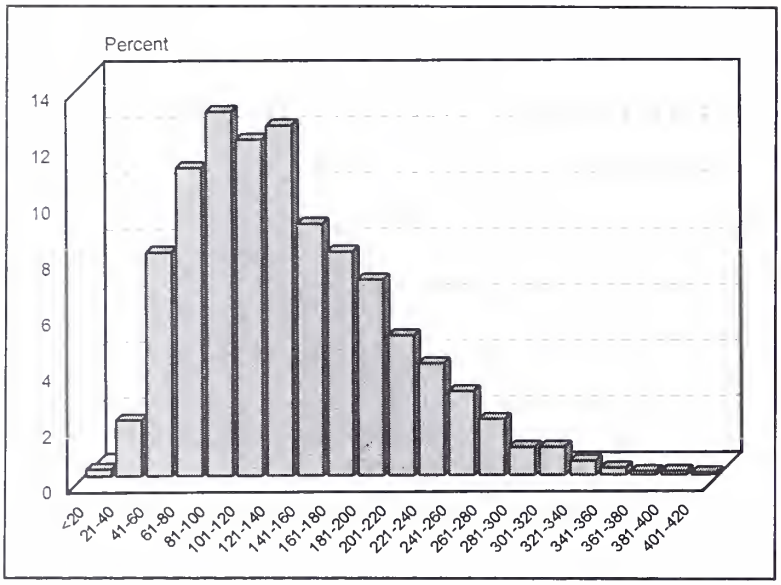

Figure 50.--Fishermen in 1989 reported a number of trunks larger than 300 kilograms as well as a substantial number of trunks over 240 kilograms.

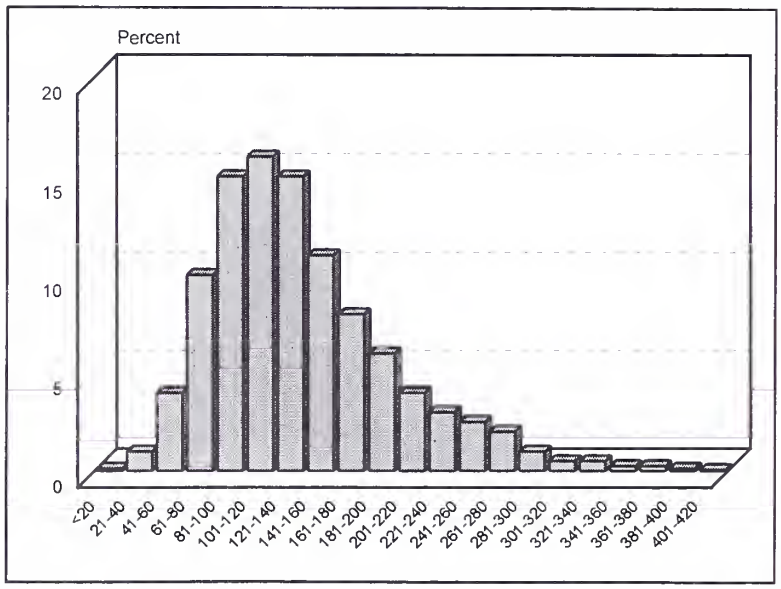

Figure 51.--Fishermen during 1989-91 reported few swordfish trunks under 60 kilograms.

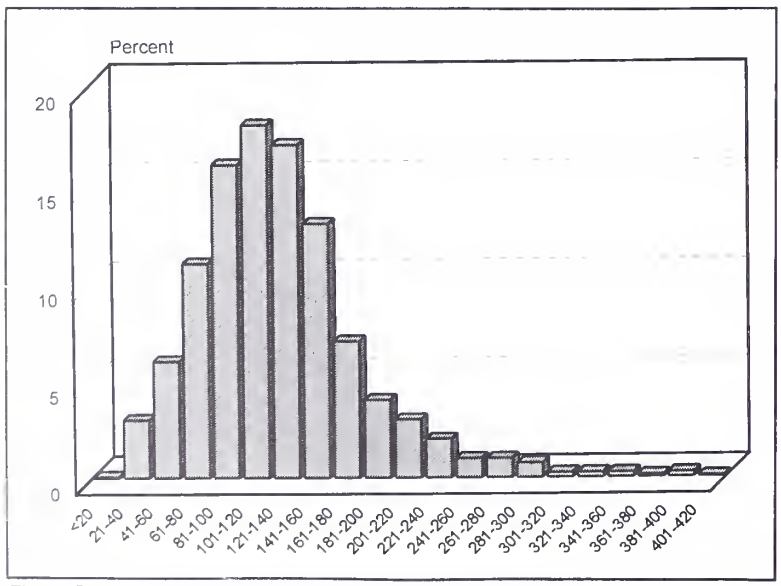

Figure 52.--The number of trunks over 240 kilograms had dropped significantly by 1991 and there were very few fish over 300 kilograms.

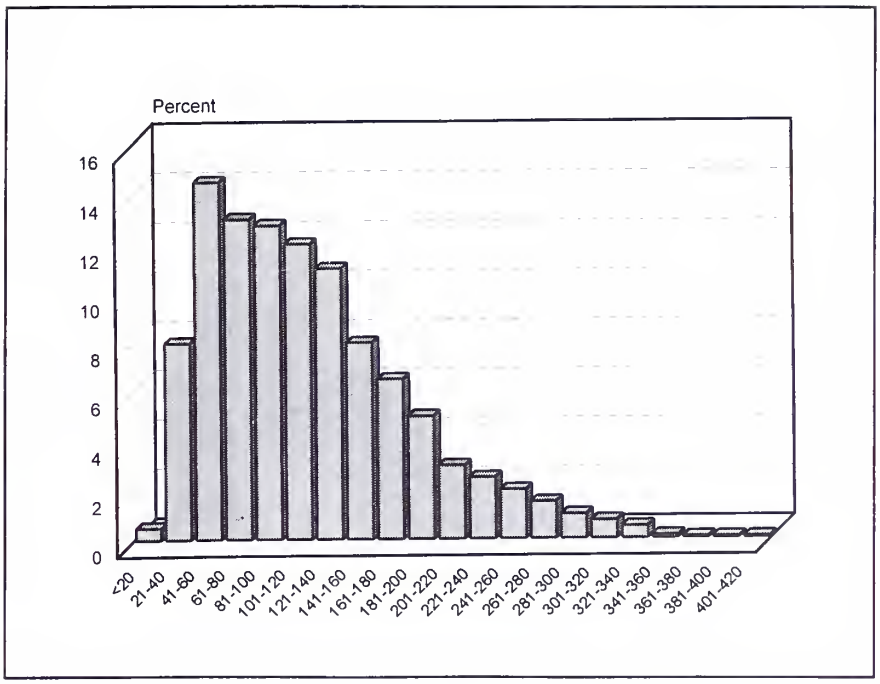

Figure 53.--Fishermen in 1992 reported very substantial numbers of trunks 60 kilograms and less.

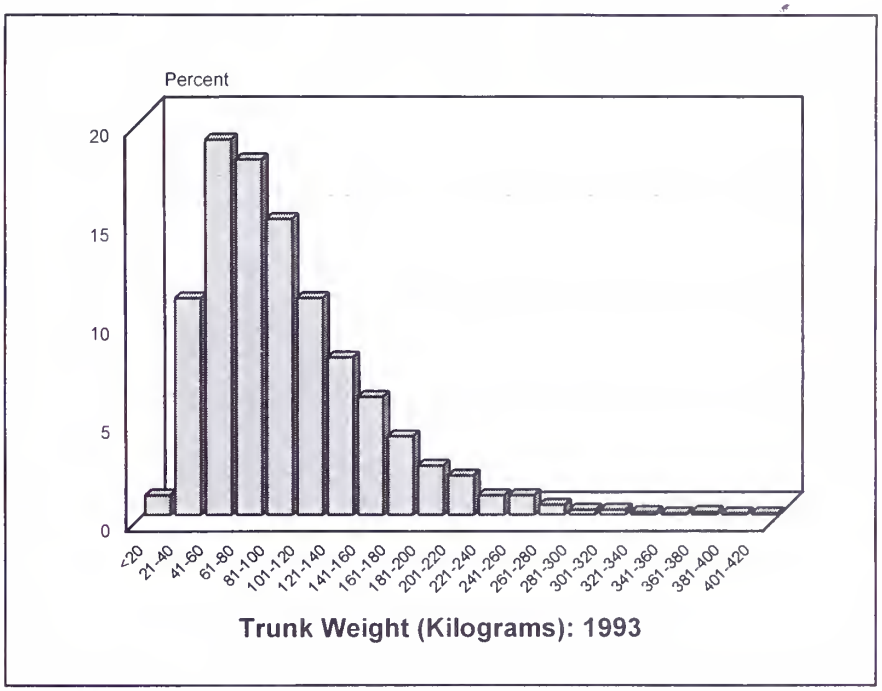

Figure 54 .--A very substantial part of the 1993 catch was composed of trunks 60 kilograms and less.

Chilean fishing effort increased rapidly during the late 1980s, but after peaking in 1993 (appendix C2a1 and figure 55) appears to have declined in recent years. Chilean fishermen reported an explosive expansion of fishing effort since the fishery was initiated in 1986. The rapid expansion of the fleet, one measure of effort, is described above. (See "Fleet.") Other measures of fishing effort also showed the massive effort mobilized in Chile. One study reported a limited effort of 4,800 days at sea (das) in 1987 which increased more than three times to 16,900 das in 1988. Effort reached 36,800 das in 1991 and 40,700 das in 1993 (appendix C2a1 and figure 55). Driftnet fishing power also increased significantly from only 0.2 million square brazas in 1986 to 30.0 million square brazas in 1990-91 (appendix C1a and figure 56).[282] One Chilean researcher reports that artisanal effort in 1994 was only slightly below peak 1993 levels, but declined sharply in 1995 to 29,500 das (appendix C2a2).[283] No separate time-line data is available on longline effort other than the statistics on the number of longliners. (See "Fleet.") IFOP reports that due to the withdrawal of artisanal vessels in 1996, fishing effort declined by more than 10 percent in 1996 (appendix C2a3, figure 57, and photo 32).[284]

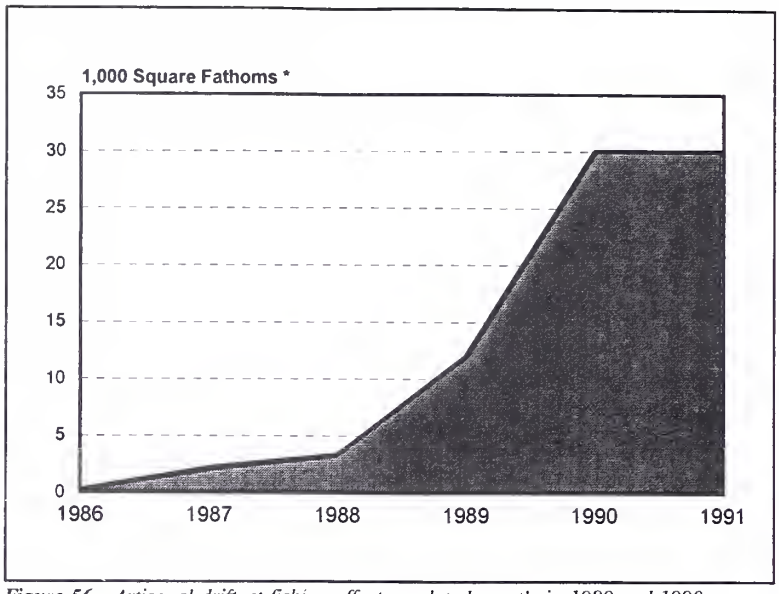

Figure 56.--Artisanal driftnet fishing effort escalated greatly in 1989 and 1990.

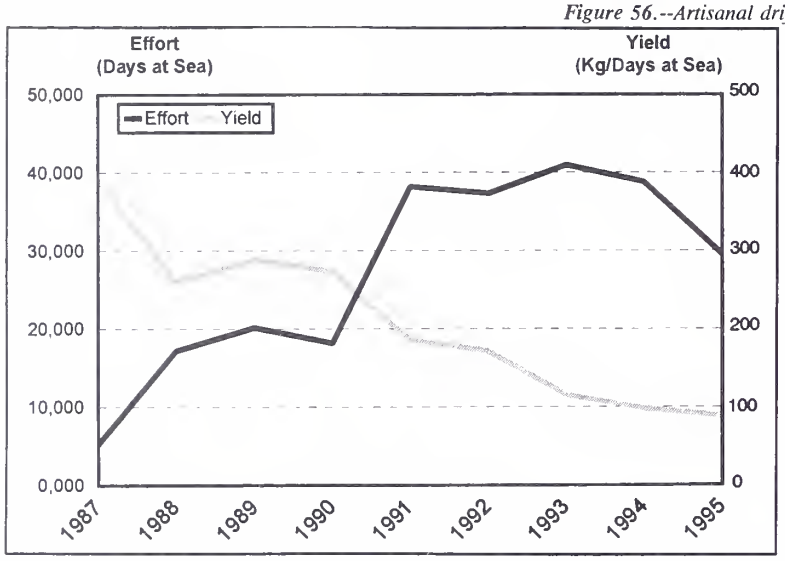

Figure 55.--Swordfish yields have fallen as effort increased --a classic curve suggesting overfishing.

Chilean effort varies substantially by port, fishing grounds, and seasonality. While only limited data is available to the authors on these fluctuations, available catch and landings data gives some indicators, however imprecise, of effort.[285] (See Series E appendices.)

Port: The primary Chilean swordfish port in most years is San Antonio (appendices C1b1-4, C2c1-2, F1, F2b, and F3 and figure 58).[286] This probably reflects the port's central location close to the most productive fishing grounds (Zones 3 and 4) and convenience to Chile's principal international airport. Other ports (such as Valparaíso) can also be very important in some years (C2b, C21-2, and F3). Often the vessels are based in different ports than those in which they land their

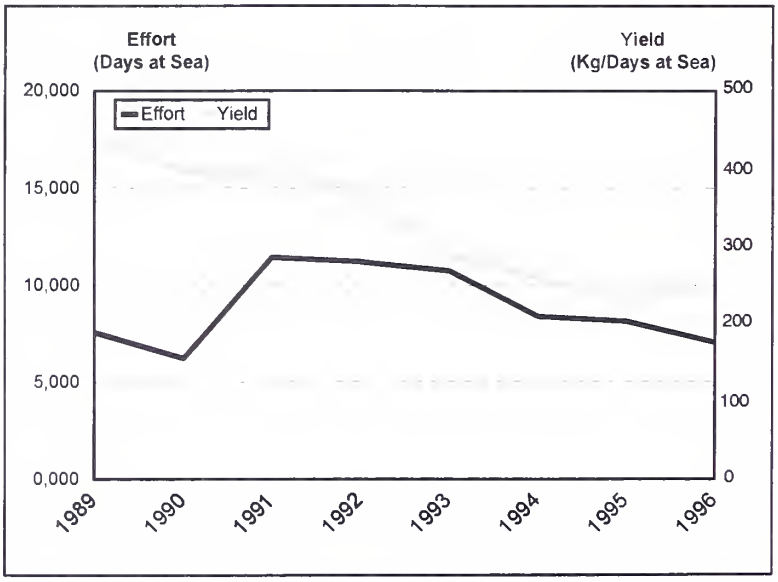

Figure 57.--Recent data suggests small increases in yields during 1996, perhaps a response to the overestimate of declining effort since 1991.

Photo 32.--Many artisanal fishermen have withdrawn from the swordfish fishery because of declining yields. Dennis Weidner.

(See "Species: Distribution.")

Grounds: Chilean artisanal and commercial fishermen focus their effort on different grounds. (See "Fishing Grounds.") The artisanal fishermen concentrate on the central and southcentral coastal areas (Zones 4 and 6) and the central offshore area (Zone 3). The commercial fishermen focus on the northern and central offshore areas (Zones 1 and 3) (appendices C2d-e and C3c-d). The only common area where both artisanal and commercial fishermen deploy significant effort is the central offshore area (Zone 3).

catch. Several vessels, for example, are based in Lebu, but they rarely land their catch there.[287] Chilean artisanal fishing effort varies seasonally as the fishermen move their vessels north along the coast, following the movement of the fish. Early in the year, substantial effort is reported from Lebu along the southcentral coast (appendices C2c2 and F2a) while later in the year the effort is centered more along the central coast, especially out of San Antonio and Valparaíso (appendices C2c1 and F2a and figure 58).

Seasonality: Much of the fishing effort takes place from March through June or July (appendices C1b1-4 and F2a). The artisanal fishing effort during 1994-95 was most intense during the Fall and early Winter, from April to June or July (appendices C2b-e). The commercial fishing effort was more varied, extending well beyond July (appendices C3a-d and figure 59).[288] Some fishing, however, is reported throughout the year.

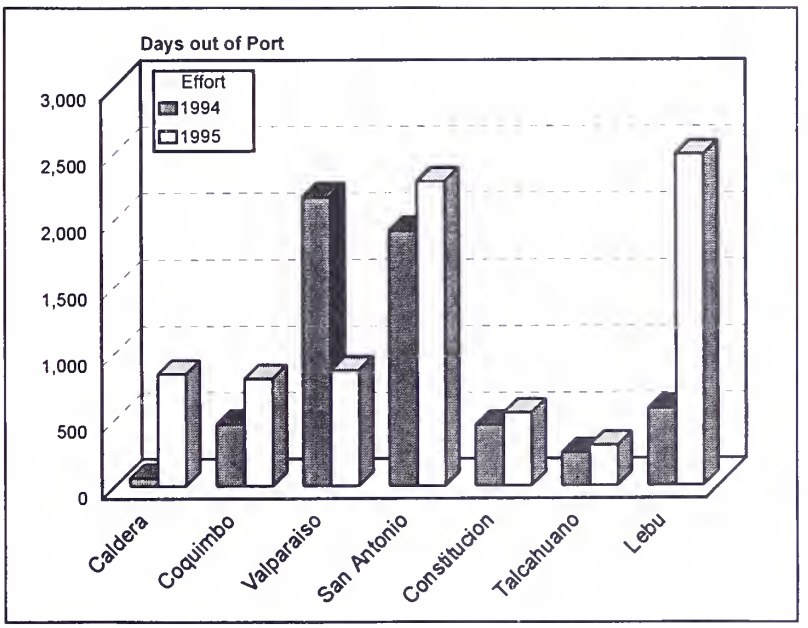

Figure 58.--Effort out of some ports (Lebu, Valparaíso, and Caldera) vary from year to year, but is more stable for many other ports.

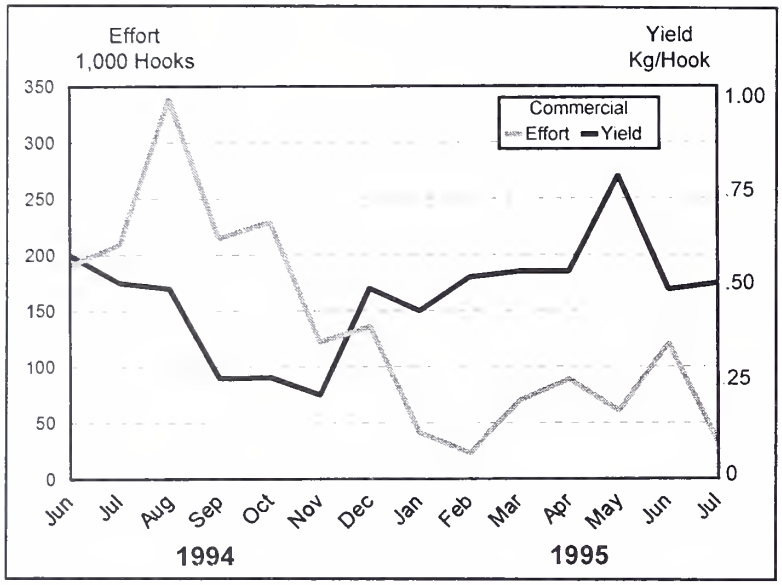

Figure 59.--The commercial fishery reports effort and yields that are less seasonal than the artisanal fishery.

N. Yield

Chilean swordfish yields have declined as effort has increased. Several Chilean studies have noted a steady decline in yields.[289] The authors note several different studies showing substantially different numbers, however they show similar, but not identical trends.[290] The catch-per-unit effort (CPUE) has declined steadily from a high of 391 kg per days at sea (das) in 1987. IFOP/UCV reported especially steep CPUE declines in 1988 (to 236 kg/das) and 1991 (to 89 kg/das). The CPUE by 1993 had fallen to only 67 kg/das (appendix C2a1). The yield from 1991 to 1993 was relatively stable, varying only from 67-91 kg per days at sea (appendix C2a1). One UCV researcher has provided somewhat different yield data, but also showing a steep decline from 1987. The high 1987 yield (391 kg/das) declined somewhat, but was still relatively high during 1988-90 (259-289 kg/das) as the Chilean fishermen expanded fishing effort. The yield declined again in 1991-92 (171-185 kg/das) which was the peak years in term of overall (artisanal and commercial) catch. Subsequent yields have declined each year. The yield declined significantly in 1993 (115 kg/das) and more moderately in 1994 (98 kg/das). Yields reached a record low in 1995 (88 kg/das) (appendix C2a2). These declining yields occurred even as many Chilean fishermen withdrew from the fishery and fishing effort, as a result fell--especially after 1992. (See "Species: Effort.") Probably as a result of the declining effort, yields increased somewhat in 1996 (appendix C2a3 and figure 57).

The cause of the yield decline can not be determined with any certainty because of the limited understanding of swordfish stock structure. Most authors, however, point to overfishing. One observer believes that the Chilean fishermen between 1988-90 may have begun to fully utilize the available resource and is concerned with the expanding fishing effort.[291] Yields can, however, be affected by various environmental factors besides overfishing. Lower yields may also be the result of a diminished availability to the fishery due to the shifting distribution, and not necessarily a decline in the stock. (See "Species: Stock status.")

Chilean yields vary substantially by port, fishing grounds, and seasonality:

Port: Chilean fishermen operating from several different ports report widely different yields, some of which may be attributable to differences in the data collection process. Artisanal fishermen from Region VIII ports (especially Lebu and San Vicente, near Talcahuano), reported the highest yields in 1991 (appendix F3).[292] Yields at these ports were about twice of that reported by the much larger fleet

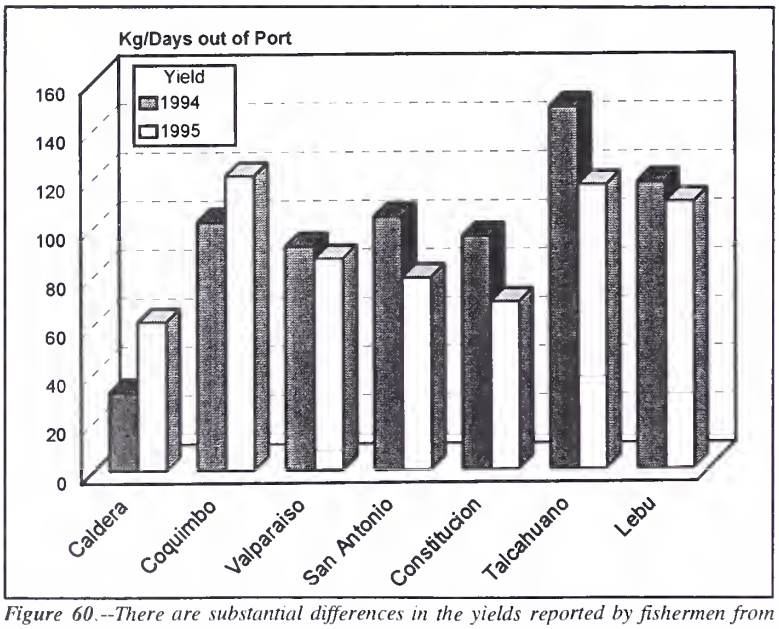

Figure 60.--There are substantial differences in the yields reported by fishermen from various ports.

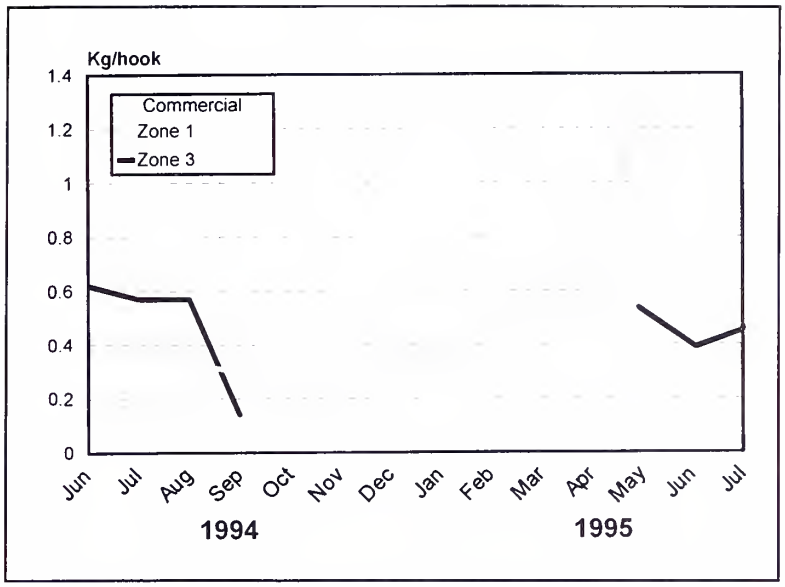

Figure 61.--The commercial fleet during 1994-95 shifted grounds seasonally, working off the northern coast during the season when coastal fishing is minimal.

operating from San Antonio. A study during 1992-93 also reported excellent yields from Lebu (appendices C1c1-2). This pattern was also noted in 1994-95 when fishermen from Lebu and Talcahuano again tended to report the highest yields--although the difference was not as great as in earlier years (appendices C2b and c and figure 60).[293] No time-line data is available on commercial longline yields, but data for 1994-95 suggest that fishermen from Coquimbo were achieving yields of 0.38-0.51 kg per hook (appendices C3a-b).

Fishing grounds: The yields on different fishing grounds vary, although little time-line data is available to the authors. The artisanal fishermen reported their highest yields during 1994 and 1995 along the southcentral coast (Zone 5) (appendices C2d and e).[294] Yields in the other areas varied in a more random pattern. The commercial fishermen reported their largest yields in the central offshore area (Zone 3) during 1994, but in the northern offshore area (Zone 1) during 1995 (appendices C3c-d and figure 61). These results, however, could have been affected by the differing months that data was available during 1994 and 1995.

Seasonality: The highest yields reported by the artisanal fishery during 1994-95 were in June and July (appendices C2b-c and C2d-e). The commercial fishery reported a more varied pattern (appendices C3a-d).[295]

O. Stock status

Some overall assessments are available for Pacific swordfish. Japanese assessments for the status of stocks in the southeastern Pacific as a whole suggest that through 1992 yields have tended downward since the mid-1970s, but are well above the extremely low levels reported in 1983.[296] Chile is the primary Latin American country fishing swordfish in the southeastern Pacific. The decline reported by the Japanese, combined with the data from Chile of falling catches and yields, suggest that there is a strong possibility that the theorized southeastern Pacific stock may be declining. Chilean catches increased in 1996, but it is not clear that this is a permanent shift away from the downward trend since 1991. Notably the 1996 increase appears to be due to a massive shift by the commercial fleet to new grounds beyond Chile's 200-mile zone (appendix E2g and figure 14).[297] Colombia and Peru through 1996 harvested negligible quantities of swordfish. The Ecuadorean situation is more difficult to assess as available data is contradictory. There appear to have been increased landings in 1996-97, but this seems to be due to the recent development of a directed swordfish fishery and opening of new grounds.[298]

Chilean biologists are developing an important data base on the swordfish population in the southeastern Pacific. The data collected from the fishery has been analyzed by IFOP and cooperating university biologists. (See "Effort" and "Yield" above.) While this data has some limitations, it does offer some important, if tentative, insights into the status of the southeastern Pacific swordfish population.

Available IFOP/UCV data combined with SERNAP catch and landings statistics suggest that Chilean fishing effort appears to be adversely affecting stocks. The existing data, despite its limitations, suggests that swordfish off Chile has been fished beyond its optimal level. The SSP reports that a preliminary swordfish stock assessment study has been prepared.[299] The current IFOP and university research effort is providing an increasing body of data upon which to base stock assessment work.

Effort: Fishing effort increased massively from 1986 to the peak in 1993. (See "Species: Effort.") Effort during 1991-93/94 continued at high levels, although Chilean sources vary somewhat on 1994 (appendices C2a1-2 and figure 55). Effort appears to have declined

substantially in 1994-95 as many vessels have been withdrawn from the fishery. (See "Fleet.") Whether the Chilean effort on swordfish has declined adequately for stocks to rebuild, or at least to stabilize, is unknown. Declining effort since 1993-94 does not appear to be resulting in improved yields (appendix C2a2). Catches through 1995 continued a very precipitous decline (appendix E2a2 and figure 93), suggesting that fishing effort was still not in balance with the available resource. Artisanal fishermen reported further declines in effort during 1996 and an actual increase in yields (appendix C2a3 and figure 57).[300] A dramatic shift to commercial fishing in 1996 (appendix E2f and figure 64), however, means that effort trends in the artisanal fishery may have less of an impact on the fishery than the commercial fishery. The authors, however, have no current data on commercial fishing effort.

Grounds: All observers confirm that Chilean fishermen are having to make increasingly long voyages to find fish.[301] Even artisanal fishermen, who once operated exclusively in coastal waters, are now operating 100-320 km off the coast.[302] (See "Fishing Grounds.") While shifting distribution could result from a variety of factors, such as changing climatic conditions, overfishing is a possible cause.

Catch: The parabolic curve formed by the rise and decline of swordfish catches since 1986 is a text book curve suggesting overfishing. (See "Catch.") The catch has declined enormously since the 1991 record of over 7,250 t (appendix E2a1 and figure 93). The 1995 catch of less than 2,600 t, represented a decline of nearly 65 percent in only 4 years. In addition, the decline continued at a rapid rate through 1995. The 1995 catch declined nearly 50 per cent from the 1994 catch (appendix E2a2). Fishermen in 1996 finally reported a catch increase, the first in 5 years. Fishermen caught over 3,100 t in 1996, primarily because of increased commercial catches in offshore waters (appendix E2g and figure 65).[303]

Yields: Yields have declined tremendously since 1987. All Chilean observers confirm this sharp decline, but different observers describe somewhat different patterns. (See "Species: Yield.") One group reported that most of the decline occurred by 1991 and that yields during 1991-93 were relatively stable (appendix C2a1). Another author has reported a steady decline since 1989 with major drops in 1991 and 1992. This study reported continued declines in 1994 and 1995. The 1995 decline, although not as great as in some recent years, was still over 10 percent (appendix C2a2). Fishermen in 1996 reported higher yields (appendix C2a3 and figure 57). Part of the increase was due to declining artisanal and commercial effort.[304] Data on commercial yields in offshore water is not yet available.

Size: The declining size of the fish being harvested is another possible indicator of overfishing.[305] Chilean fishermen are reporting a steady decline in the size of the fish being landed. (See "Species: Size decline.") The commercial longline fishermen have from the beginning taken quantities of small fish. The artisanal driftnet fishermen, however, initially took relatively large fish. As the artisanal fishermen through 1995 landed the bulk of the catch, the smaller sizes they reported were especially troubling. There were no restrictions on the sizes which could be harvested. (See "Gear and Fleet Operations.") One Chilean researcher, however, warns that available size data must be used with caution and that declining average sizes may reflect the fishermen's shift to offshore grounds where the fish are smaller.[306] (See: "Species: Size decline" and Fishing Grounds.")

Several factors could explain the declining swordfish stock off Chile:

Domestic effort: The substantial catch effort deployed in the early 1990s is presumably a major factor. (See "Species: Effort.") The authors note that artisanal fishing effort by 1990-91 had reached extremely high levels, although different assessments provide sharply different estimates (appendices C2a1-3). Less information is available on commercial effort. (See "Species: Effort".)

Foreign effort: Foreign fishermen, especially Japanese and Spanish, may also be having an impact on southeastern Pacific swordfish stocks.[307] Swordfish are highly migratory species and several countries conduct substantial longline fisheries in the Pacific, either for swordfish or for other oceanic pelagics like tuna. (See "International.") It is possible that the fisheries of these countries on the highseas may be contributing to the declining catches and yields off Chile. Chilean fishermen often point to the foreign fishermen as the principal problem causing the decline in the Chilean catch. Foreign fishing countries, however, are not reporting large swordfish catches in the southeastern Pacific (FAO area 87) to FAO (appendix E5 and figure 15).

<u>Honduras</u>: Honduran operations in the southeastern Pacific are limited. There are no catches reported to FAO, but there may have been small catches which were not reported. The Chilean Navy reported one Honduran vessel, *Urgora*, active in the southeastern Pacific during 1996-97 (appendix D4). The vessel called at Talcahuano in April 1997 because of an accident in which a member of the crew was hurt.[308] Few details are available on operations, but the call at Talcahuano suggests operations off central Chile. The vessel is almost certainly owned by foreign interests and operated under a Honduran flag-of-convenience registry.[309]

Japan: The principal country reporting southeastern Pacific swordfish catches is Japan, but its 1994 catch in the area of 690 t was less than 20 percent of the Chilean catch and the 1995 catch of only 480 t was even less (appendix E5 and figure 15).[310] The Japanese swordfish catch in the southeastern Pacific results primarily from incidental catches associated with the tuna longline fishery. The Japanese primarily target tuna because it commands prices about twice that of swordfish.[311] The Fisheries Agency of Japan (FAJ) reports that there are no Japanese Government restrictions limiting the size of swordfish taken by Japanese Pacific longline fishermen in the Pacific.[312] The Japanese Federation of Tuna Fishery Cooperative Associations (Nikkatsuren) reports, however, that only a limited by catch of small swordfish are taken in the mid-water longline fishery.[313] The Japanese Distant Water Fishery Research Laboratory (Enyo Suisan Kenkyujo) reports that the by-catch of small swordfish is much less than 10 percent, but no data on size composition is available. The small fish are reportedly discarded because they have no commercial value in Japan.[314] Japanese yield data indicates that CPUE increased from 1962-1977, but then decreased from 1977-1983. Significant increases were reported during 1983-86. A limited decline has been noted since 1986. The CPUE in 1992 was reported about the same as that noted during the early 1980s.[315] Current Chilean Navy surveillance reports give no evidence of significant Japanese activity off Chile during 1996-97 (appendix D4).[316] Given the swordfish catch which the Japanese report to FAO, their effort should not be having a decisive impact on the stock. Their fishing, combined with that of Spain and Chile, however, does add significant fishing pressure, although their yield data does not show such a large decline as the Chilean data.

Spain: The only other country conducting significant swordfish operations in the area is Spain, but they have not reported their catch to the FAO during the 1990s.[317] (See: "International.") Despite their failure to report these operations, the Spanish have taken substantial quantities of swordfish in some years. Apparently 10-15 Spanish longliners fished swordfish in the southeastern Pacific in the early 1990s. Such operations have since declined, but continue at a lower level. The Chilean Navy reports that eight Spanish longliners (*Carvisa III, Depreador, Espadarte, Maicoa, Maicoa I, Radochei I*, and *Rosu III*) were active in 1996-97 (appendix D4). The vessels call at Chilean ports for a variety of reasons, including the purchase bait and supplies, repairs, crew injuries, and others.[318] They are not permitted, however, to tranship their swordfish catch through Chilean ports. (See "Transshipments".) Most of the Spanish vessels do this at Ilo or other Peruvian ports (Peru, photos 36-46).[319] The Spanish would prefer to make these transshipments through Chilean ports as they are closer to the fishing grounds. Significantly they operate under no size limitation and have reportedly been taking significant quantities of small, juvenile fish.

Pressure on juveniles: The extensive harvest of juvenile fish by both Chilean and foreign longline fishermen before the fish mature and spawn could be having a major adverse impact on the fishery. The increasing artisanal driftnet take of juveniles is another concern. (See "Species: Year classes.") The SSP officials managing swordfish are especially concerned about the impact of taking juveniles.[320]

Environmental/Climatic factors: Climatic or other environmental factors may also be diminishing the abundance or availability of the fish.[321] Researchers have demonstrated that long-term climatic shifts have affected swordfish and fish stocks.[322] Some observers believe that El Niño events have affected the

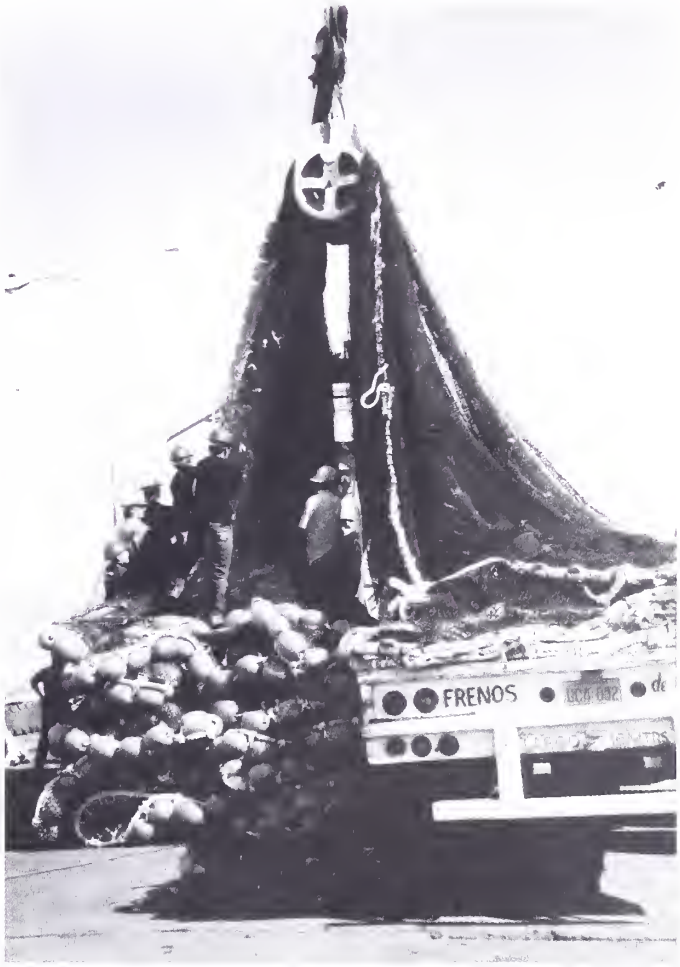

Photo 33.--Chilean fishermen using giant seines have greatly increased fishing pressure on jack mackerel in recent years. Dennis Weidner.

Chilean swordfish population.[323] El Niño events are usually fairly brief, often lasting only a few months or a year, but there are some which have continued for longer periods. The swordfish catch off Chile has been declining since 1991. Such a decline would require a macro environmental event to cause such a protracted decline The abnormal pattern of El Niño events during the early 1990s could have affected the stock or displaced the population. Two El Niño events occurred during the early 1990s (1990-95) that were much closer together than is common. As a result, average sea surface temperatures during this period in the equatorial Pacific were somewhat higher than average.[324] Chilean fishermen report having to go increasing distances from the coast to find the temperature conditions optimal for swordfish.[325] (See "Gear and Fleet Operations.") One possible explanation of the need to make larger voyages is a climatic shift associated with the abnormal El Niño pattern, although any such linkage would require a detailed assessment. Ocean temperatures by 1996 had returned to more normal levels and in late 1996 were actually below average.[326] Temperatures in mid-1997, however, increased sharply and climatologists are predicting a major El Niño event in 1997-98 which is already have a substantial impact on some fisheries.[327] (See "Species: Temperatures".)

Pressure on fodder species: Fishing pressure on jack mackerel, a primary swordfish prey item, has increased significantly during the 1990s (photo 33). Researchers have reported substantial variations in jack mackerel stocks since the 1970s.[328] First Soviet and now Chilean fishermen have begun to harvest very large quantities of the species. Some Chilean industry sources believe that this is a major reason for the declining catch, but are unclear as to whether stocks have been reduced or just displaced.[329] This species appears to be one of the primary swordfish fodder species off Chile. (See "Species: Feeding behavior.") Fishing on jack mackerel doubled from 2 million t in 1986 to 4.0 million t in 1991 (appendix B2d and figure 41). Notably this corresponds to the initiation of significant Chilean swordfish operations in 1986 to the peak Chilean catch in 1991. Jack mackerel catches declined in 1992 and 1993 with the withdrawal of the Soviet fishing fleet, but reached new record levels in 1994 (4.3 million t) and 1995 (5.0 million t). The jack mackerel fishery was the world's second largest in 1995, exceeded only by the massive Peruvian harvests of anchovy. The removal of such a large quantity of important fodder species could be a key factor adversely affecting the swordfish stock as well as other oceanic predators.

Chilean officials are greatly worried about the status of swordfish stocks in the southeastern Pacific. The Sub-Secretaría de Pesca (SSP) is especially concerned with the falling catch-per-unit effort and the declining average size of the fish caught. Chilean researchers have used models to assess the population and even with the limited available data, the results give cause for concern.[330] The SSP in 1996 prepared a technical report to set minimum sizes based on indirect assessment methods. The SSP used this report as a basis for new minimum size regulations issued in 1997. (See "Government Agencies and Policies".)

III. Fishing Grounds

The southwestern coast of South America is perhaps the world's most productive fishing ground. The huge population of small pelagic and other species support populations of highly migratory predators. Environmental conditions for swordfish off the coast of Chile and Peru appear optimal. It is perhaps no accident that the largest swordfish ever landed by recreational fishermen was taken off Chile's northern coast. Artisanal fishermen have reported even larger individuals. One noted sport fisherman, S. Kip Farrington Jr., referred to Chilean coastal waters as the "greatest swordfishing ground in the world."[331]

A. Oceanography

Chile's 4,200 km coastline is one of the longest most diverse coastlines in the world. The Chilean coast stretches from the dry, barren north to the craggy, icy island of Tierra del Fuego (photo 34). No other country has a contiguous north-south oriented coastline covering such a wide range of latitudes--extending nearly 40 latitudinal degrees--and, as a result, has such varying oceanic conditions. Chilean waters run from temperate waters along the Peruvian border (18/19°S) to semi-Antarctic waters off the country's southern tip at Cape Horn (56°S). In addition, Chile claims a section of Antarctica extending the country's claims into the Antarctic Ocean.

Photo 34 --The Atacama Desert in northern Peru is one of the driest, most barren areas in the world. Even further south, the landscape is very barren. Dennis Weidner

Chile's 200-mile zone is greatly enlarged by several island groups in the southeastern Pacific. Chile has jurisdiction over: Islas Desventuradas (San Félix/San Ambrosio) (26°S, 80°W), Islas Juan Fernández (Robinson Crusoe and Alejandro Selkirk Islands) (33°S, 79-80°W), Easter Island (27°S, 109°W), and Sala-y-Gómez Island (26°, 105°W) (photo 35). Easter Island is the furthest extension west of Chilean jurisdiction and is located about 3,700 km from the mainland coast. Oceanic ridges connect many of these islands. The Nazca Ridge running southwest from the Peruvian coasts terminates at Islas San Félix/San Ambrosio. The Sala-y-Gómez Ridge then runs west to Sala-y-Gómez and Easter Islands.

The Continental Shelf is extremely narrow along the Chilean coast and the decline to the ocean floor is striking. In only a few kilometers, the Andes with peaks exceeding 6,000 m fall into a longitudinal marine fracture up to 8,000 m deep. This is the most precipitous decline any where on the planet. Off northern Chile the shelf is especially narrow and may only extend 15 km from shore. Along most of the coast, especially along the central coast, the shelf extends about 40 kilometers. The southern coast is significantly different. South of Puerto Montt there is a labyrinth of islands and fjords (photo 36). The shelf broadens, but even along the southern coast is rarely more than 80 km from the shore.

High fisheries productivity off Chile is largely attributed to the movements of oceanic water masses and by associated changes brought about by prevailing winds.

Currents: Chilean coastal waters are dominated by the northerly flowing Humboldt Current.

West Wind Drift/Circumpolar Current: In the southeastern Pacific, there is a net eastward movement of water, known as the Southern West Wind Drift (figures 17 and 62). The prevailing winds and rotation

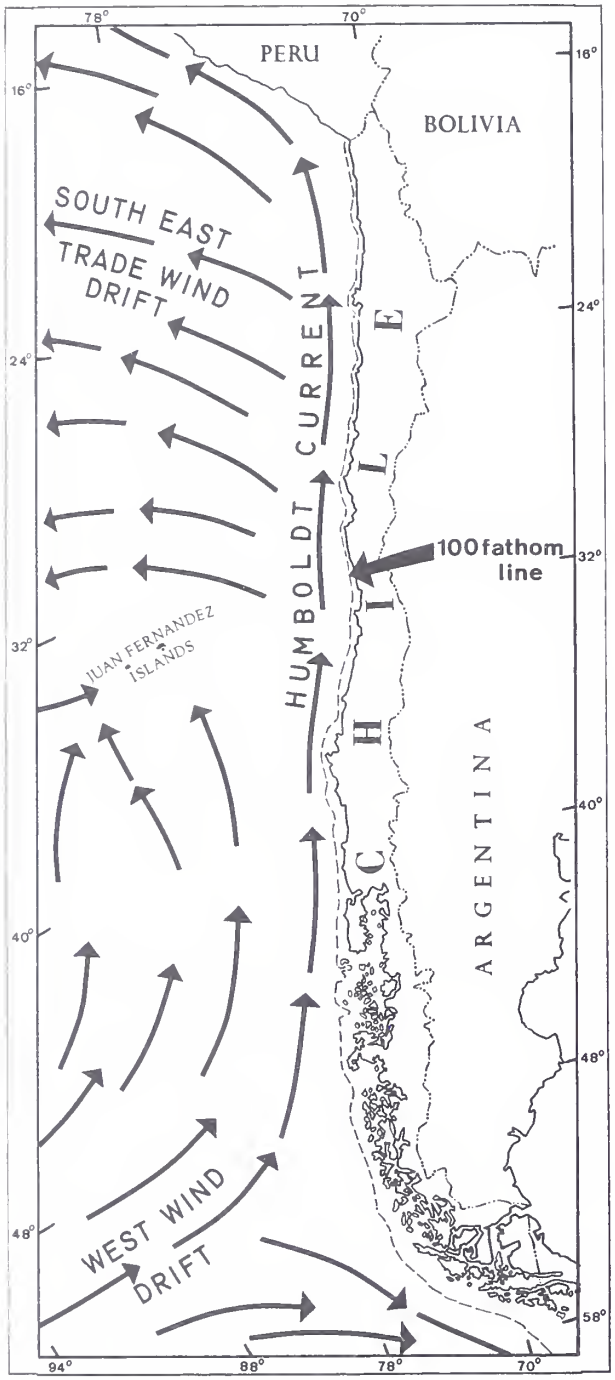

Figure 62.--Schematic representation of surface currents off the coast of Chile.

of the earth drive the surface currents south of 35-40°S (between the Sub-Tropical and Sub-Antarctic Fronts) west toward the South American coast (Colombia, figure 10). The surface currents at these southerly latitudes are rich in plankton as they approach the Chilean coast at about 50°S and divide. A southern branch flows southeast around Cape Horn. The northern branch becomes the Humboldt or Chile/Peru Current.

Humboldt Current: The Humboldt Current flows northward along the Chilean and Peruvian coast.[332] This Current is sufficiently powerful to lower SSTs along the Pacific coast of South America several degrees from the adjacent oceanic averages.[333] Its effect is felt seasonally as far north as Ecuador (figure 12). Chilean coastal waters are dominated by this northerly flowing cold current.[334] The Humboldt Current varies, but off northern Chile is generally about 25-30 km off shore and about 25 km wide. The flow appears to be particularly powerful at depths from 30-125 meters.[335] Current flows have frequently been reported from 8-19 cm per second with a maximum transport of 5.1 million m per second.[336] The cooler water in the current creates sharp ocean temperature fronts. There are also associated eddies, some of which appear to be relatively permanent features.[337] These areas are rich foraging grounds for oceanic predators and thus often potentially good swordfish grounds. Some Chilean fishery researchers have begun to assess the relationship between oceanographic features and swordfish distribution.[338]

South Pacific Gyre: Oceanographers report a counter clock-wise flowing gyre well out into the Pacific off Chile. The location and flow of the gyre has been variously described by different authors.[339] Such pronounced current flows could affect swordfish movement, although it is difficult to confirm such relationships in the absence of tagging data. (See "Species: Migrations".)

Upwelling: Embedded in the Humboldt Current is a strong upwelling circulation which further lowers the temperature of coastal waters (within 100 km from the coast).[340] Chilean coastal waters, already affected by the cold Humboldt Current, are thus lowered another 2-4°C. At various locations along the Chilean and Peruvian coasts, southerly and southeasterly winds carry surface waters away from the coast and colder waters are drawn from moderate depths toward the surface, a process known as upwelling (Peru, photo 13). Upwelling systems provide optimal conditions for primary productivity, enriching the upper levels of the water column with organic detritus drawn up from the bottom. As a result, coastal areas affected by upwelling are some of the richest, most productive fishing areas in the world. The colder upwelled water, rich in nutrients, enhances the growth of plant plankton. This is the basis for the phenomenal abundance of marine resources off Chile--particularly off the country's northern and central coasts.[341] The upwelling zone off Chile extends from 40°S north to the Peruvian border (18°S). The upwelling system off Peru and Chile is the most productive in the world.[342] Thus Chile, a country with almost minuscule shelf area, is one of the leading fishing countries in the world (photo 37).

Photo 35.--Chile's southern coast is sparsely populated with many islands and pristine fjords. Dennis Weidner

Oceanic currents and upwelling play a significant role in swordfish fishing strategy for several reasons:
Primary productivity: The extremely high primary productivity afforded by the Humboldt Current and upwelling support massive populations of fodder species. The small pelagics (especially jack mackerel, anchovy, and sardine) caught off Chile and Peru are some of the world's largest fishery resources (photo 38). These large populations, or the species that prey on them, support sizeable populations of highly migratory predators like swordfish. Both Peru and Chile have reported substantial historical swordfish catches. (See "Catch".) Both artisanal and recreational fishermen have reported taking very large swordfish off Peru and Chile, especially Chile.[343]
Current flow: It is notable that one suspected migratory path for southeastern Pacific swordfish appears quite similar to the oceanic current flow along the Chilean coast and adjacent oceanic areas. (See "Species: Migrations.") The circular current flow of the South Pacific gyre in the southeastern Pacific (figure 17) would correspond to a possible swordfish circular migratory path.[344] This assessment, however, is very tenuous because of incomplete catch data at southern latitudes where the Japanese fishermen, targeting bigeye, have not extensively fished. As the Chilean fleet shifted to oceanic grounds in 1996, more data may become available on areas that have not been extensively fished by the Japanese.
Temperatures: Swordfish occur in waters from 13-24°C. Some Chilean fishermen report their best results in waters from 16-19°C, but catches are reported in warmer water. (See "Species: Temperatures/Spotting techniques.") Such temperature conditions are common off central and northern Chile (figure 16 series).
Thermal fronts: Fishermen report that they often find swordfish along thermal fronts near the Humboldt Current where the oceanic water is about 18-20°C and the water in the current itself is colder.[345] The fishermen use satellite remote sensing data to locate

Photo 36.--Many islands are located within the 200-mile coastal zone, like Isla Mocha, on the Shelf along the central coast, as well as several oceanic island groups. D. Weidner

Photo 37.--Chile has built a modern fleet and fishmeal industry based on small pelagics. These species also support a rich ecosystem, including swordfish. Dennis Weidner

such promising conditions and jack mackerel concentrations (figure 90).[346] (See "Gear and Fleet Operations: Remote sensing.") Chilean researchers have studied the strong relationship between swordfish abundance and thermal fronts along the Chilean and Peruvian coast where giant squid, anchovy, and dinoflagellate blooms are abundant.[347]

Oceanographic events and long-term climatic cycles can cause substantial fluctuations in the eastern Pacific fisheries catch, especially at tropical and subtropical latitudes.

Oceanographic events: Short term oceanographic events like el Niños can have major impacts on fisheries. The Ecuadorean fishery catches since 1985, for example, have ranged from 0.3 million t (1993) to 1.1 million t (1991) (Ecuador, appendix B1a). Peruvian catch fluctuations since 1970 have been even more dramatic, falling from a phenomenal 12.5 million t (1970) or by over 80 percent as a result of the classic 1972 el Niño to only 2.3 million t (1973). This decline in only 3 years was the most precipitous drop ever reported in world fisheries (Peru, appendix B1). Chilean catches, on the other hand, while affected by el Niño warming events, have not been as significantly impacted. Chilean catch fluctuations have also been sizeable, but generally not nearly as destructive as off Peru and Ecuador. The Chilean catch, for example, only fell from 1.4 million t (1970) to 1.2 million t (1973), although it declined further to 1.0 million t (1974). The Chilean catch never fell anywhere near 80 percent as did the Peruvian catch.[348] This is in part because the equatorial warming associated with el Niño has less effect at the more southerly latitudes off Chile. Also the species most affected by the el Niño, anchovy, is of less importance to Chile than Peru where it dominates the fishery. Even so, el Niño events can have major impacts on apex predators like swordfish and other oceanic predators when the key small pelagics

Photo 38 --Chilean fishing grounds are some of the most productive in the world, yielding huge harvests, primarily harvested by purse seiners. Dennis Weidner

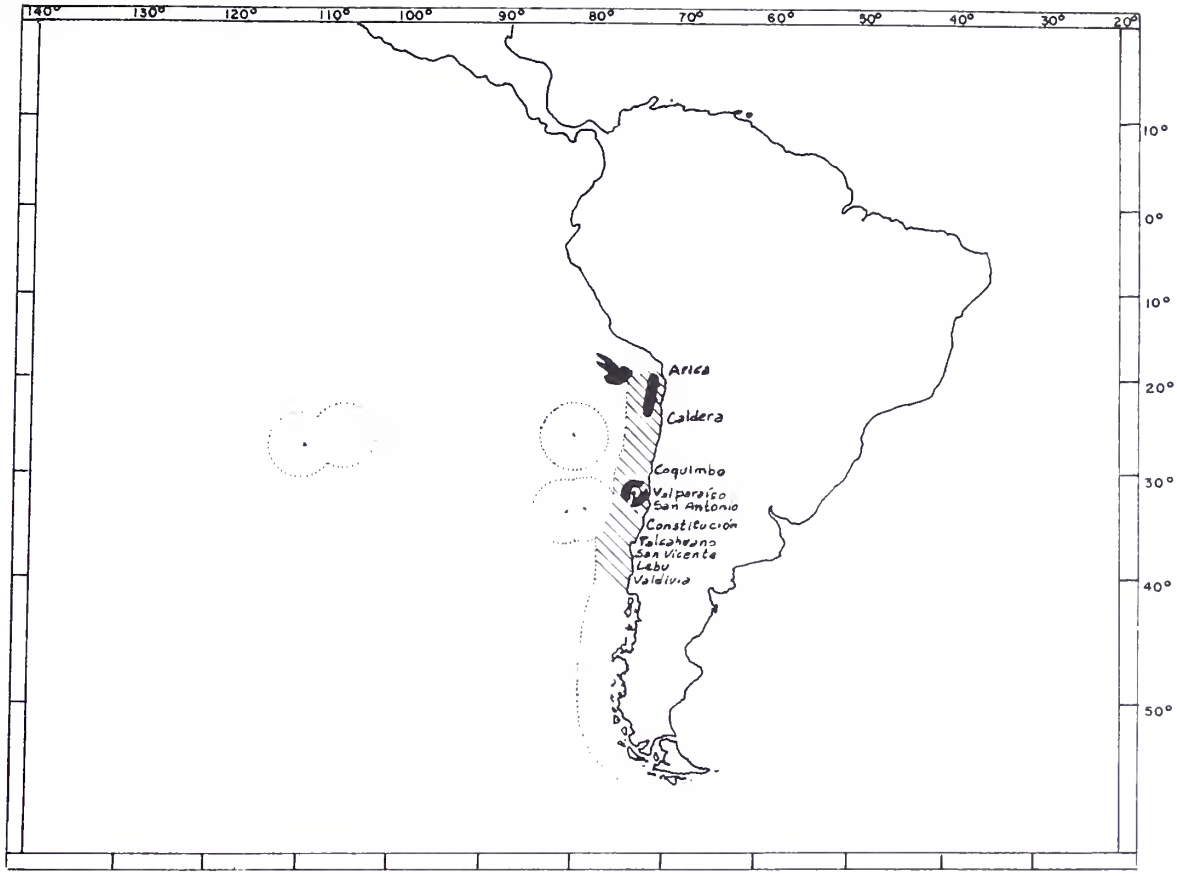

Figure 63 --Chile's swordfish fishing grounds in 1991 F. Ponce. Since 1991, the fishery has moved to the west and in 1996 most of the catch was taken beyond the 200-mile limit.

(anchovy, jack mackerel, and other small pelagics) are impacted. (See "Species: Temperature.")

Climatic cycles: Long-term climatic cycles are also known to impact populations of oceanic pelagics.[349] No detailed assessment has been completed of the impact of climatic cycles on swordfish populations. Some Chilean researchers, however, have begun to assess the relationship.[350]

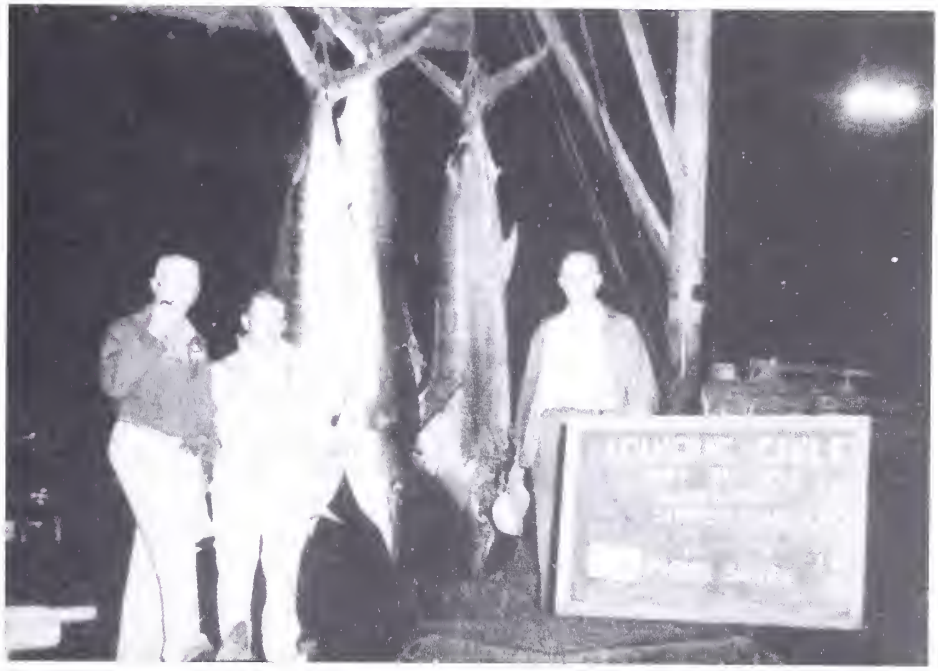

Photo 39 --American sport fishermen seeking swordfish and other species fished extensively off northern Chile during the early 1950s, especially out of Iquique Dennis Weidner

Photo 40.--The artisanal fishermen who initiated Chile's swordfish fishery at first fished close to the coast, but have gradually been forced to operate at increasing distances. Dennis Weidner

B. Fishing areas

Chilean fishing grounds have shifted significantly in recent years. Historical information indicates that the primary grounds of the artisanal harpoon fishermen at the peak of that fishery (1930s-50s) was off the northern coast. The current artisanal driftnet fishery (1986-to date) focuses primarily on the central coast and takes only minimal quantities off the northern coast. The commercial longline fishery which began operations in 1989 is conducted in offshore areas, off both northern and northcentral Chile (figure 63).

1. Historical information

The artisanal harpoon fishery active during the 1930s-50s was almost exclusively carried out along the northern coast.[351] (See "Gear and Fleet Operations.") The catch was landed in the northern ports of Arica (18°S) and Iquique (20°S).[352] Some fishing was also reported from Antofagasta (24°S). One observer noted in the 1950s that swordfish were never landed south of Caldera (27°S).[353] The recreational fishery active during the 1930s and 50s was also conducted primarily out of northern ports like Iquique (photo 39). While there appears to have been almost no actual fishing off the central coast, it seems likely swordfish were present. There is archeological evidence of indigenous peoples consuming swordfish along the central coast. Presumably the fish along the northern coast were more accessible to the fishermen. It is not clear to the authors, however, why the fishery during this period was confined to the northern coast, other than the shelf is very narrow in the north.

2. Current fishery

The Chilean swordfish fishery is conducted almost exclusively in the southeastern Pacific, primarily off the northern and central coast. Artisanal fishermen focus on the central coast within 120 miles (192 km) of the shore (photo 40). Commercial fishermen operate more to the north beyond a 120-mile coastal zone. The overall pattern changed in 1996 with a significant shift to grounds beyond Chile's 200-mile zone. The changes reported in 1996 may persist for some time, but this cannot be confirmed at this time.

1995: Most of the catch in 1995 was taken by artisanal fishermen in coastal waters along the central and southcentral coast. This is roughly confirmed by port landing data (appendix E3b1 and figure 23), although as discussed above, even artisanal fishermen can land their catch at some distance from the fishing grounds. While there may be some commercial fishing at latitudes off Peru, there is virtually no Chilean fishing off southern Chile.[354] Catches landed from southern and northern ports are currently minimal. While limited data is available on the area in which catches are taken, the data on the ports where the artisanal catch is landed (the bulk of the catch through 1995) suggests that the artisanal catch was landed along the central and northcentral coast and only limited quantities of fish were taken along the northern and southern coasts.[355] This is confirmed by the partial-year data available on 1994-95 catches by ocean area (appendix E2h2 and figures 67-70). The catch within Chile's 200-mile zone usually constitutes 80-90 percent of the country's catch (appendix E2b and figure 14). One IFOP report indicates that the artisanal fishery is mostly conducted from 27-40°S and within 200 km of the coast.[356] Since 1991 commercial fishermen have begun conducting operations in the Pacific on the highseas at increasing distances from the coast. These catches peaked at 20 percent of the overall swordfish catch in 1993, but declined in 1995 to only about 10 percent. A few vessels have also ventured into the south Atlantic, working out of Montevideo in Uruguay.

1996: Chilean fishermen dramatically changed grounds in 1996. The artisanal fishery which had dominated the fishery declined precipitously to only 630 t or 20 percent of the catch (appendix E2f and figure 64). This meant that pressure on heavily fished coastal grounds targeted by these fishermen along the central and northcentral coast dropped precipitously. The commercial fleet, however, reported dramatic catch increases, reaching over 2,500 t or 80 percent of the catch. The commercial fishermen significantly shifted their fishing grounds. Previously they had operated along the northern and northcentral sectors of Chile's 200-mile zone on the outer fringe, but generally within the zone. Fishermen in 1996 for the first time reported operations primarily outside the 200-mile zone. The fishermen took 2,300 t of their 2,500 t catch or over 90 percent in international waters--mostly in the southeastern Pacific (appendix E2g and figure 65). Most of this was taken at latitudes off northern and northcentral Chile, usually at distances of about 500-800 kilometers. There has also been fishing around the Juan Fernández Islands off Central Chile and in 1996-97 some particularly good catches were reported between Robinson Crusoe and Alejandro Selkirk Islands two of the main islands in the Juan Fernández group.[357] In addition, companies continued to deploy a few boats out of Montevideo.

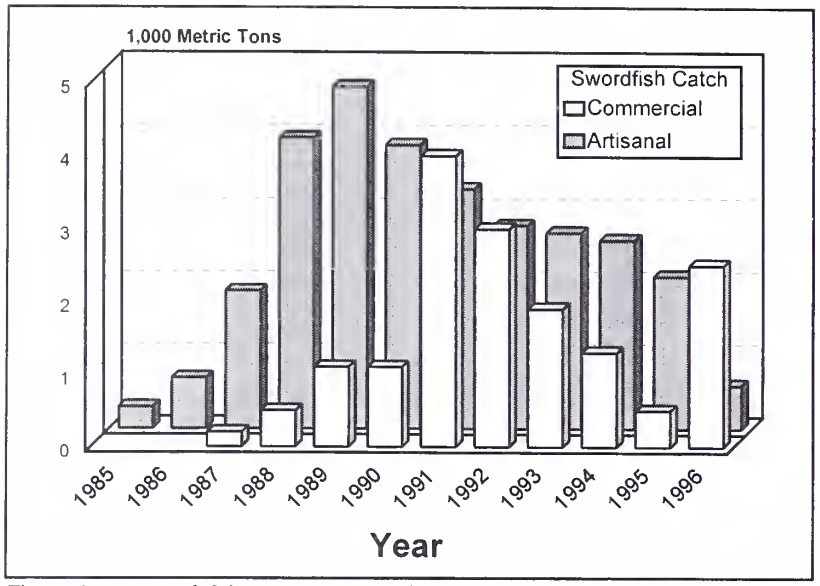

Figure 64.--Artisanal fishermen reported only a small fraction of the 1996 catch, but the commercial fishery expanded significantly.

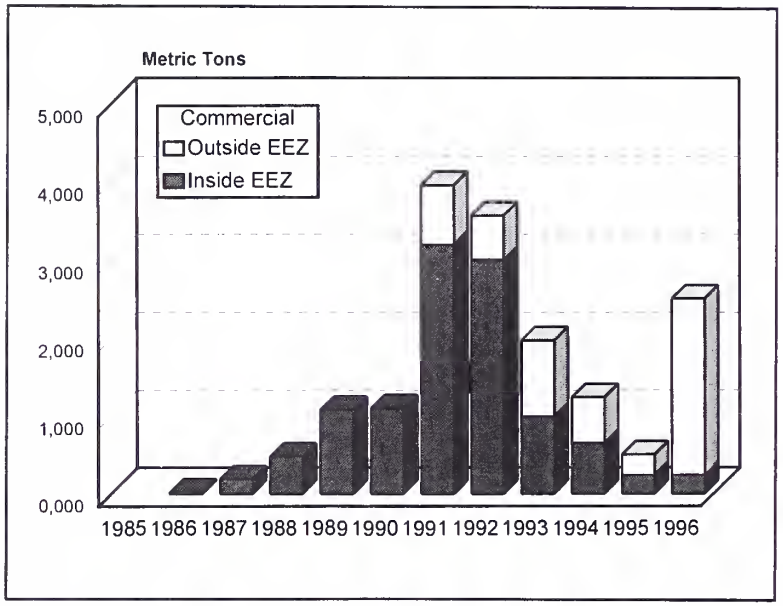

Figure 65.--In most years, the commercial catch was taken inside the 200-mile zone. In 1996, however, the catch was mostly taken outside the 200-mile zone.

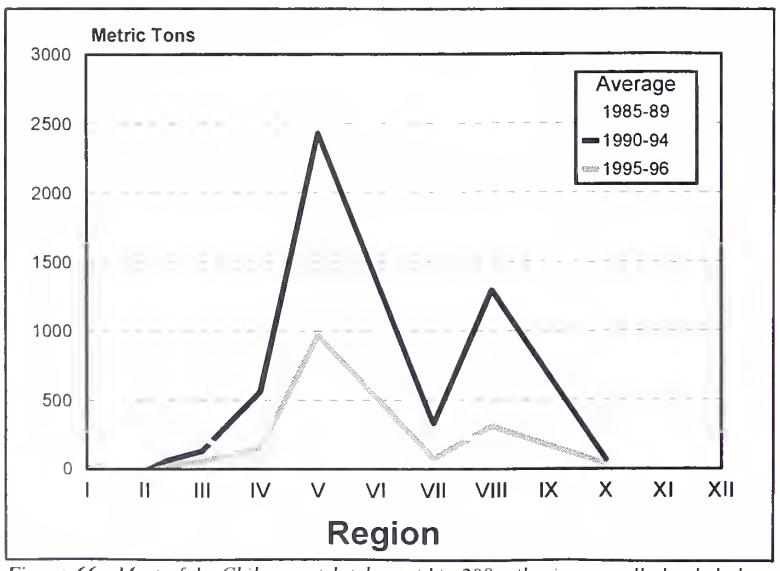

Figure 66.--Most of the Chilean catch taken within 200-miles is generally landed along the central cost at ports in Regions V and VIII.

a. Southeastern Pacific

Swordfish occur in commercial quantities along both Chile's northern and central coast at varying distances from the coast. Some data is available on fishing grounds through 1995. The shifting fishing grounds during 1996 suggest a fundamental change in fishing patterns off Chile, although it is to early to confirm that the fishery has shifted primarily to grounds outside Chile's 200-mile zone. The limited range of the small artisanal vessels and the inability to shift to grounds further off the coast partially explains their poor 1996 catch.

Latitude: Fishing operations in recent years have normally been conducted from Chile's northern border with Peru (18°S) and, as far south as Concepción (37°S).[358] Some fishing also took place off southern Peru to the north of 18°S.[359] Occasional landings are reported along the southcentral coast, in Region X, the area around Chiloé Island (42-43°S). The bulk of the of catch is taken along the central coast which is partially confirmed by landings data (appendix E2e1 and figure 66). The changing 1996 fishing pattern appears to have resulted in a decided shift north. The artisanal fishermen landed much less fish in 1996 (photo 41). This would mean in 1996 that less fish was taken off the central coast and more fish was landed off northern Chile as the commercial catch increased sharply (appendix E2g and figure 65). IFOP confirms that the 1996 catch was mostly taken off the northern coast.[360]

Artisanal: The artisanal fishermen continue to operate primarily along the central and northcentral coast. The fleet has recently operated from 27-40°S but often concentrates on 33-35°S.

Commercial: The commercial fleet generally focuses on latitudes off the northern or north central coast (19-33°S). A few vessels also operate off the central coast in waters around the Juan Fernández Islands (33°S) and particularly good catches have been reported there in 1997.[361]

Distance from coast: The Chilean swordfish fishery not only varies from north to south, but also westward off the coast. The distance is primarily due to the different ranges of the artisanal and commercial vessels, but the commercial fishermen dramatically shifted to the west in 1996, outside of Chile's 200-mile zone (photo 42).

Artisanal: Initially the fishermen conducted artisanal operations using harpoons and operated very close to the coast. The fishermen gradually extended operations further off the coast as they have shifted to more commercially oriented operations using driftnets and longlines and acquiring larger vessels.[362] Fishermen operating out of Valparaíso, for example, were fishing only about 60 km off the coast in 1987 when the fishery was just beginning. As the fishery has expanded with new entrants, the fishermen reported having to move further and further offshore to find fish. Artisanal fishermen fish within 190 km (120 miles) of the coast and in recent years often concentrate about 130-160 km from shore.[363]

Commercial: Government regulations require that the commercial fishermen fish outside of a 120-mile (192 km) coastal zone reserved for the artisanal fishermen. Commercial fishermen were reportedly operating 250 km off the coast in 1990, but have gradually shifted operations west. Fishing at 320 km was reported in 1993.[364] The fishermen by 1996 were operating and even greater distances. Some companies in 1996 report operating more than 1,300 km offshore.[365] Such distances were unusual, but the fishermen in 1996 took most of the catch outside Chile's 200-mile zone. The fishermen took 2,300 t of their 2,500 t catch in international waters--mostly in the southeastern Pacific

Photo 41.--Lower 1996 catches and the withdrawal of many vessels have sharply decreased effort along the central coast of Chile. Dennis Weidner

Photo 42 --Chilean commercial fishermen are fishing beyond the country's 200-mile zone. Dennis Weidner

Photo 43.--Chilean fishermen now conduct the world's second largest fishery, a purseseine fishery for jack mackerel. Dennis Weidner

(appendix E2g and figure 65). This would mean at distances beyond 480 kilometers. The bulk of the commercial fleet appears to have operated about 480-640 km offshore. A small number of vessels fished around the Juan Fernández Islands.[366]

The 1996 shift to offshore grounds are not fully understood. A variety of factors could be involved.

Jack mackerel fishing: The increasing fishing pressure on jack mackerel is decreasing the availability of this important fodder species in coastal waters. Swordfish may be adjusting to this displacement by moving west.[367] Jack mackerel is known to be an important prey item, especially in coastal waters. (See "Species: Feeding".) Chilean fishermen have increased pressure on the resource in recent years and the fishery is now the second largest on a single species any where in the world (photo 43). Chile reported a catch decline in 1996 (appendix E1b and figure 4).

Climatic shifts: One observer speculated that changing current patterns have meant that waters with optimal fishing conditions are now located further off the coast.[368] The authors do not have data confirming this shift, but it certainly is plausible that oceanographic events or long-term cycles could affect swordfish distribution. (See "Species: Stock status.")

Fishing pressure: The great growth of fishing effort during the 1990s (appendices C2a1-3 and figures 55 and 57) may have adversely affected stocks. (See "Species: Effort".) This may have forced fishermen to seek new grounds. Fishermen may also have fished out resident populations located in inshore waters.[369]

Processing shift: A shift to fresh product may have changed the economics of the fishery so that highseas operations are now economical.

Other: A wide variety of other factors may be involved.

Little information on the profitability of offshore operations is available. Local observers report that offshore operation were not particularly profitable in 1995, but this situation appears to have changed dramatically in 1996. The decision of the commercial fishermen to focus on fresh product appears to have fundamentally changed the economics of the fishery.

1995: Many observers reported in 1995 that the increasingly distant offshore operations is significantly affecting the fishery because the fishermen are reporting lower yields as they move further and further offshore.[370] Data from the artisanal fishery indicate that yields continued to decline on coastal grounds in 1995 (appendices C2a2-3 and figures 55 and 57). Very limited actual data, however, exists comparing yields in offshore and inshore fisheries during comparable time periods.[371] (See "Species: Yields.")

1996: Artisanal fishermen withdrew from the fishery because of the declining profitability of the swordfish fishery and high prices for alternative species. While they thus reduced effort, actual catches fell even more (appendices C2a3 and E2g and figures 57 and 65). This suggests that the artisanal shift out of the fishery may not be a short lived phenomenon (photo 44). This contrasts starkly with the greatly improved 1996 results of the commercial fishermen which must mean the fishery is profitable or the fishermen would not continue operations at such increased levels (appendix E2g and figure 65). The decision to shift to fresh product may have changed the economics of the fishery. The authors, however, have no data on the yields being achieved beyond the 200-mile zone.

1997: Preliminary reports suggest that artisanal catches will be substantially higher than in 1996. (See "Catch".) This suggests that the artisanal fishermen who withdrew from the fishery in 1996 did not do so permanently. Commercial fishermen continue to report

Photo 44 --The need to fish on distant grounds has made it increasingly difficult for artisanal fishermen in their small boats to participate in the fishery. Dennis Weidner

the bulk of the catch, suggesting that their decision to focus on fresh fish is resulting in profitable operations.

IFOP in 1995 published the first study of Chilean catches by fishing grounds. IFOP has divided the grounds targeted by the Chilean fleet into six coastal and oceanic zones stretching from 18°S (the border with Peru) to 41.5°S, slightly south of Valdivia and stretching from the coast westward to 88°W, or about 2,000 km off the coast. There are three coastal zones (2,4, and 6) and three oceanic zones (1, 3, and 5) (figure 24). This is the only published Chilean data known to the authors indicating where the Chilean catch is taken. The oceanic areas (Zone 1, 3, and 5), however, are quite large and no published information is available on the fishing patterns within these zones. The IFOP sampling during parts of 1994 (June-December) and 1995 (January-July) suggest the following pattern:

1) Coastal fishery

Chilean fishermen report their best catches along the central and northcentral coast, however, swordfish abundance is highly seasonal. (See "Species: Seasonality.") The coastal fishery is conducted exclusively by artisanal fishermen. Both SERNAP artisanal landings data and limited IFOP data on coastal fishing zones confirm that the Chilean artisanal swordfish catch is primarily taken along the central and northcentral coast.

Available landing and catch data show the following pattern:

Landings: Detailed landings data prepared by SERNAP provide some insights into distribution because of the limited autonomy of the artisanal fleet. Landings are primarily reported along the central coast, especially at San Antonio (Region V) (appendix E2e1 and figures 2 and 66).[372] Landings in San Antonio accounted for 60-80 percent of artisanal catches from 1985-96 (appendix E3b2, figure 22 and photo 45).[373] Artisanal landings along the northern coast are minimal. While the landings data is available for many years, it is not the best indicator of the fishing grounds. Many artisanal vessels operate at some distance from their home ports also and may fish at considerable distance from San Antonio. The fishermen land their catch at the port because of its proximity to Santiago's international airport--allowing for quick air shipment to export markets.

Catches: IFOP has prepared some catch data by fishing zones (appendices E2h1-2 and figures 24 and 67-70). While the IFOP data shows actual fishing grounds, it is only available for a few months during 1994-95. The coastal areas stretch from the Peruvian border (about 18°S) south to Valdivia (about 41.5°S) and include the 192 km (120-mile) zone reserved for the artisanal fishermen. The limited available data on the fishing zones in which the fish are caught confirm that the northcentral coast (Zone 4) and the central coast (Zone 6) are the coastal areas in which the fish are most abundant, both in terms of catch and effort. Artisanal yields are relatively similar in both zones, for example, 91 (Zone 4) and 93 (Zone 6) kg/days out of port (dfp) during 1995 (appendices C2d-e).[374] Available 1995 catch data for part of the year suggests that over half of the total catch and 90 percent of the coastal catch was taken in those two zones (appendices E2h1-2 and figures 24 and 67-70).[375] Operations in the three coastal zones are as follows:

<u>Zone 2</u> (18-28°S): The northern coastal zone was previously the primary fishing area for the artisanal harpoon fishery. (See "Gear and Fleet Operations.") Currently this zone is targeted to some extent by the

Photo 45.--San Antonio is heavily used by both artisanal and commercial fishermen because it is close to fishing grounds and convenient to Santiago's international airport. Dennis Weidner

artisanal fleet, but yields were low and it is the least important of the three coastal zones (appendices C2d-e). Effort during 1995 peaked from April to June. Artisanal catches are minimal and the commercial fleet does not operate in the coastal zones (appendices E2h1-2 and figures 24 and 67-70).

Zone 4 (28.0-35.5°S): The northcentral coastal zone is one of the two most important grounds for the artisanal fleet. It was the most heavily fished ground in 1994 (appendix C2d) and nearly half of the artisanal catch in 1994 was taken there (appendix E2h1 and figure 67). Much of the effort is deployed from April to July. Yields appear comparable to the northcentral oceanic (Zone 3) and southern coastal zones (Zone 6) (appendices C2d-e). The commercial fleet does not operate in the coastal zones.

Zone 6 (35.5-41.5°S): The central coastal zone is another major ground for the artisanal fleet and was the most heavily fished ground in 1995 (appendix C2e). More of the catch was reported from this zone than any of the six zones in 1995 (appendix E2h2 and figure 68). Fishing effort is extensive from February to July/August and appears to peak from March to June/July. Yields are comparable to the other principal fishing areas, the northcentral coastal and oceanic areas (Zones 3 and 4) (appendices C2d-e).[376] The commercial fleet does not operate in the coastal zones.

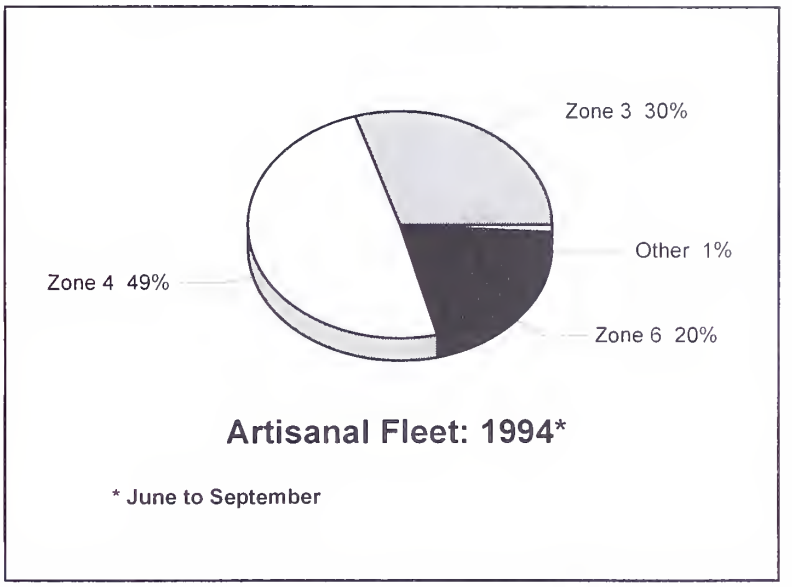

Figure 67.--Most of the artisanal catch from June on in 1994 was taken in coastal waters along the northcentral coast (Zone 4).

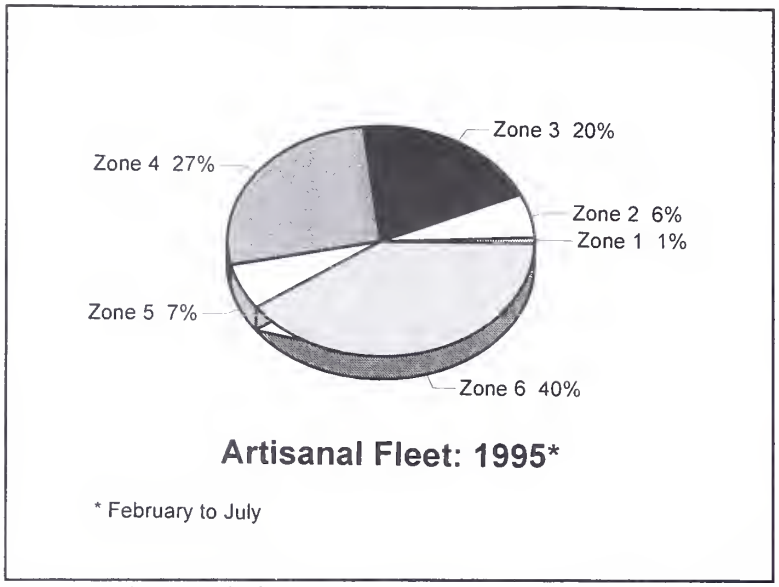

Figure 68.--The artisanal fishermen reported much higher catches in the central coastal zone (Zone 6) during the beginning of the year.

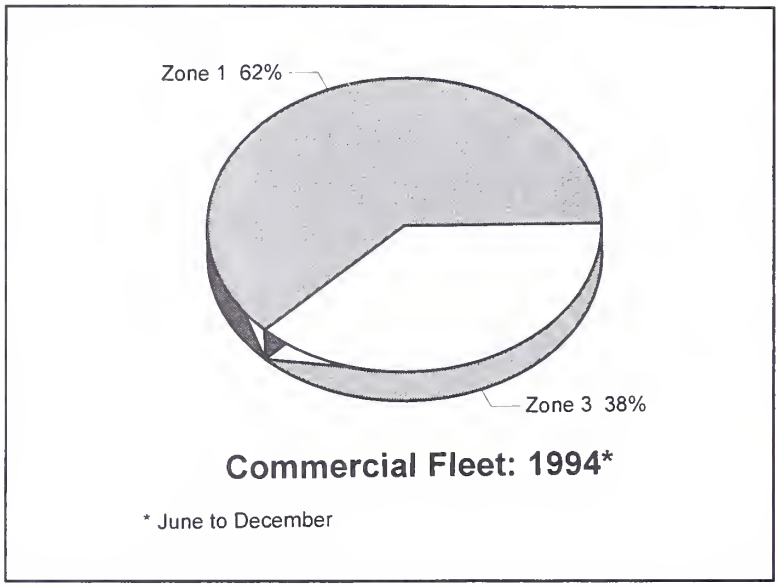

Figure 69.--Commercial fishermen in 1994 primarily targeted the northern oceanic area (Zone 1).

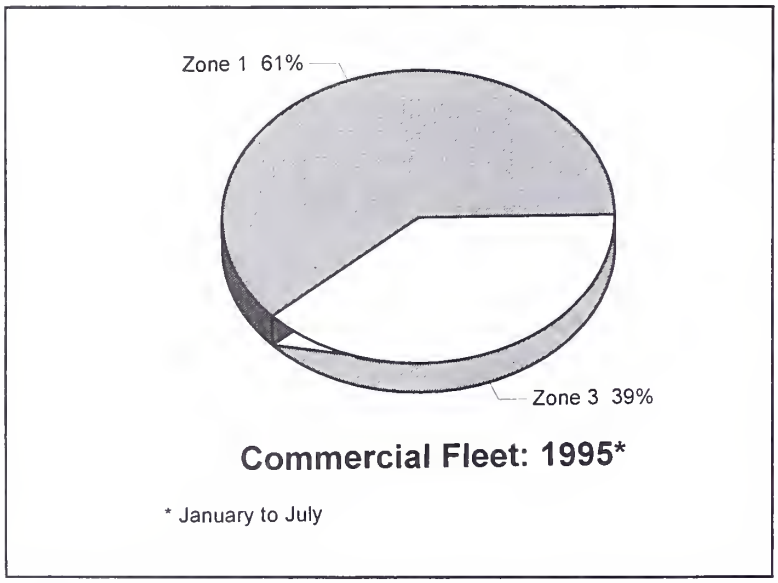

Figure 70.--Commercial fishermen during 1995 also fished primarily in the northern oceanic area during the first part of the year.

2) Offshore fishery

a) Chile

The Chilean southeastern Pacific fishery is conducted both inside and outside the country's 200-mile zone. The use of satellite data in recent years has played an especially important role in opening offshore grounds to the fishermen.[377] The satellite imagery has enabled driftnet and longline fishermen to efficiently locate potential fishing areas. Given the large area involved, fisheries in offshore areas would be extremely costly to conduct, as well as result in low yields, if the fishermen had to devote extended periods to finding appropriate conditions through at sea observations.

Within the 200-mile zone: The commercial fishery is restricted to offshore grounds beyond the 120-mile coastal zone to protect artisanal fishermen. (See "Government Agencies and Policies.") The commercial fishermen in most years have taken substantial quantities of swordfish in offshore waters, but within the 200-mile zone (appendix E2g and figure 66). With the acquisition of larger artisanal vessels, the artisanal fishermen have also extended operations well beyond the coastal waters initially targeted. The artisanal fishing on offshore grounds, however, is conducted within Chile's 200-mile zone, although precise details on where is not available. The fishing grounds in offshore waters targeted by the commercial fishermen currently are further to the north than the coastal fishery conducted by the artisanal fishermen.

Outside the zone: Operations outside Chile's 200-mile zone can be considered distant-water operations, despite being conducted just outside Chilean waters. The swordfish fishery is in fact the most extensive distant-water operation conducted by Chile's large, but still primarily coastal fishing industry. (See "Fishing Industry Overview.") The area has been included within the zones developed by IFOP (figure 24) and described below. Much of the catch described below in Zones 1 and 3, is taken beyond Chile's 200-mile zone. The fishermen first reported catches beyond 200-miles in 1991. During 1993-95, about half of the Chilean commercial catch and in 1996 most of the catch was taken outside the 200-mile zone (appendix E2g and figure 65). Companies are operating at increasing distances from the coast (photo 46). Chilean vessels during the 1990s have been gradually shifting operations westward to greater distances off the coast. This shift was particularly notable in 1996. The fishermen now appear to have approached the westward limits of the IFOP oceanic zones. The most westerly fishing operations known to the authors have been conducted by Pesquera del Estrecho which operates as far as 1,300 km offshore (about 85°W).[378] As the commercial fishing is within Zones 1 and 3, the Chilean distant-water fishery is conducted within a band westward from 18°-41°30'S. There may be some Chilean fishing north of 18°S off Peru, but if so it is probably limited.[379] SERNAP catch data for operations in international waters is only available for a few years. It peaked at nearly 1,000 t in 1993, or over 20 percent of the overall Chilean swordfish catch. The distant-water catch declined in 1995 to less than 300 t, or a little more than 10 percent of the catch (appendix E2b and figure 14). As mentioned, above, however, that was a dramatic shift in 1996 and the catch beyond 200 miles increased to 2,300 t or 90 percent of the catch (appendix E2b and figure 14). It is unclear, however, how permanent this shift will be. Artisanal fishermen

Photo 46 --Chilean companies have several modern longliners capable of operating well out into the Pacific for extended trips. Dennis Weidner

in coastal waters, according to preliminary reports, are reporting somewhat improved 1997 catches. (See "Catch".)

Available landings and catch data show the following pattern:

Landings: The commercial longliners operating within Chile's 200-mile zone in 1990s have landed at various ports, including Coquimbo (Regions IV), San Antonio (Region V), Constitución (Region VII), and Talcahuano (Region VIII) (appendix E4d1 and figure 71). SERNAP landings data show that during the early 1990s (1990-94), most of the catch was landed in these ports. San Antonio in recent years has become the major port. In 1995, over 50 percent of the catch taken within 200 miles was landed at San Antonio (Region V) (appendices E4d1-2 and figure 72). Even a greater proportion was landed at San Antonio in 1996 (figure 73), but the lack of data for the fish taken beyond the 200-mile EEZ distorts the landing pattern by region. Almost certainly Region IV is more important than suggested by the landings data. No data is available on the ports where the longliners operating outside the 200-mile zone land their catch, but it is believed to be similar to the domestic fishermen, primarily Coquimbo and to a lesser extent San Antonio.[380] This probably means the fish were taken off the north and northcentral coast as one of the reasons the fishermen are landing in Coquimbo is that it is a north/northcentral port near the fishing grounds.[381] Given the very substantial catches beyond the 200-mile EEZ in 1996, the available port landing data only reflects the pattern for a small part of the catch.[382] Previously there seems to have been more activity along the southcentral coast. A significant proportion of the commercial catch was landed as far south as Constitución (Region VII) and Talcahuano (Region VIII), especially from 1989-92 (appendix E4d and figure 71). It is unclear if this reflected more fishing, and presumably a greater abundance further south, or if other factors were involved such as deliveries to specific processing plants.

Catch: The limited catch data available by fishing zones precludes a definitive description of offshore grounds. The commercial catch is all taken in offshore waters. Available catch data for 1994-95 by zone does show that the commercial vessels only operated in the northern (Zone 1) and northcentral (Zone 3) zones and that there was no activity in the central zone (Zone 5) (appendix C3a and figures 24 and 59). The limited available catch and yield data show varying levels of catches in the two zones exhibiting no discernable pattern (appendices C3c-d and E2h1-2). Artisanal fishermen are also active in offshore waters, especially along the central area (Zone 3) which is one of their three major fishing areas. Artisanal yields in the northcentral offshore zone (Zone 3) appear comparable to the north central and central coastal zones (Zones 4 and 6) in which the artisanal fishermen also focus their effort (appendices C2d-e). Operations in the oceanic or offshore zones involve:

Zone 1: The northern oceanic zone is rarely targeted by the artisanal fleet (appendices C2d-e). The commercial fleet reported its major effort in this zone (appendices C3c-d and figure 61) and most of their catch was taken here (appendices E2h1-2). Fishing can takes place year-round, but the actual pattern varies from year to year. Commercial fishermen during 1994 appear to have shifted north as the season progressed, although the limited number of months for which data is available make it difficult to assess the pattern (appendix C3c). The commercial fishermen during 1995 appear to have reversed this pattern and shifted south as the season progressed. They began operating in the north (Zone 1) during January while they did not begin their fishery off the central zone (Zone 3) until May, suggesting fleet movements from north to south (appendix C3d).[383] The best yields during 1995 were reported in the north (Zone 1) (appendix C3d and figure 61).

Zone 3: The northcentral oceanic zone was targeted by the artisanal fishermen and the zone is of some importance to them, the only oceanic zone where significant artisanal effort is reported. Effort appears to peak from March through August (appendix C2e). Yields appear comparable to those reported in the central coastal zone (appendices C2d-e). The commercial fleet also targets the central zone. They appear to take less fish than in the northern oceanic zone, but yields in 1994 were relatively good (appendices C3c-d and figure 61).

Zone 5: The central oceanic zone is only lightly fished by the artisanal fleet. Although relatively high yields have been reported there in both 1994 and 1995, this could be a statistical anomaly due to the limited effort (appendices C2d-e). The commercial fleet does not target this zone, the only one of the three oceanic zones which it avoids (appendices C3c-d). The small artisanal effort and the lack of commercial effort strongly suggest that swordfish abundance is limited in this zone.

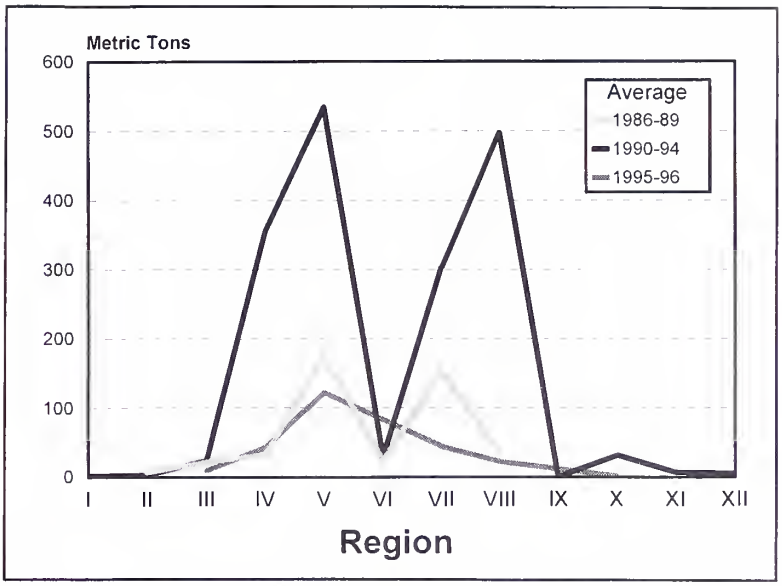

Figure 71.--Commercial longliners generally land their catch along the central coast. In recent years San Antonio has become particularly important

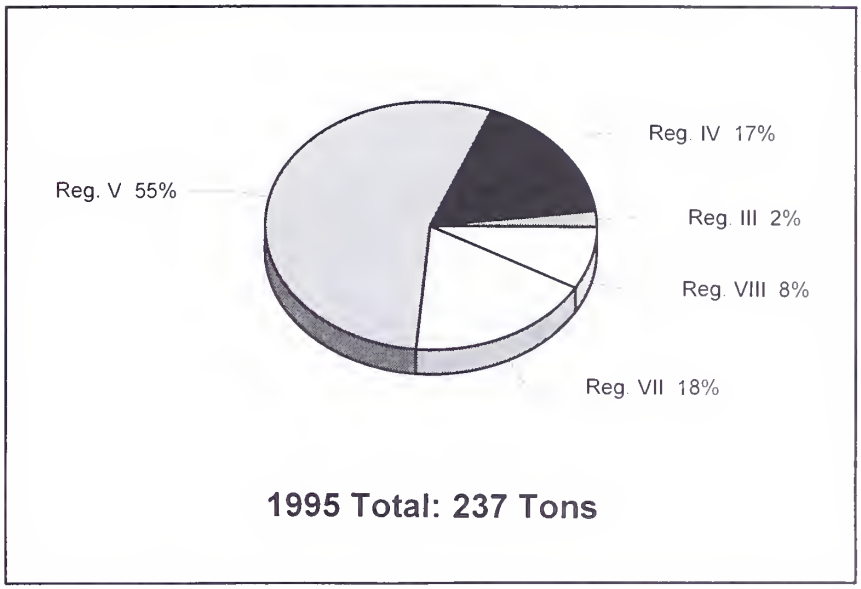

Figure 72.--Over half the domestic (within 200-miles) commercial longline catch in 1995 was landed in Region V (mostly San Antonio, because of the nearby Santiago International Airport).

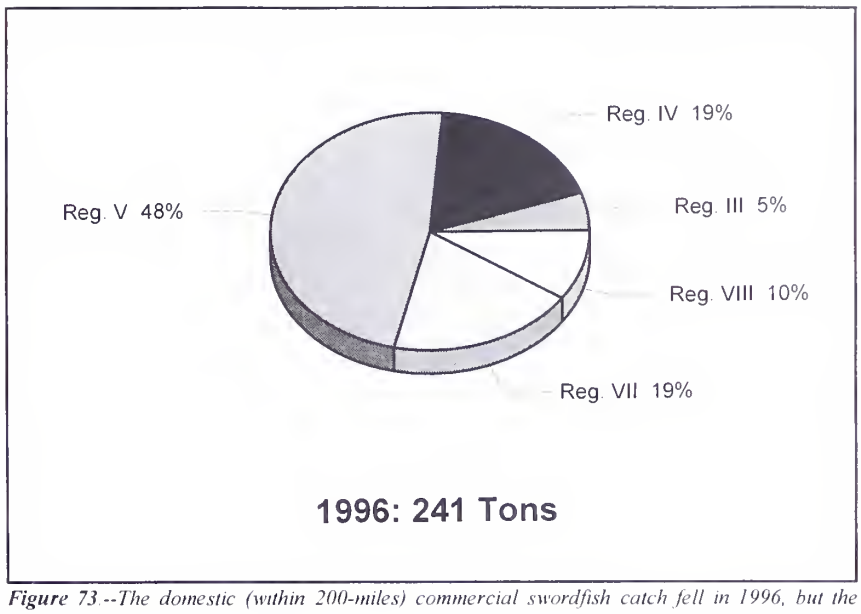

Figure 73.--The domestic (within 200-miles) commercial swordfish catch fell in 1996, but the landing patterns by region were little changed

Photo 47.--Spanish longliners are also active in the southeastern Pacific. Their range of operations extends further south and further offshore than Chilean vessels. José Echandía Zegarra

b) Foreign

The most extensive data on fishing grounds off Chile has been compiled by foreign fishermen. Unlike the Peruvians, the Chileans have not authorized foreign fishing for tuna and swordfish in their coastal waters. The foreign fishing has thus been conducted only in oceanic areas off Chile. The primary distant-water fishing country in the southeastern Pacific is Japan. The Japanese fishery has targeted bigeye, primarily in tropical waters. The Japanese fishery is significant, however, and some effort has also been deployed at the more southern latitudes off Chile. The Spanish do target swordfish and operate in the more temperate areas of the eastern Pacific. They do not, however, release data on their operations. The success of Spanish and Japanese operations to the north west and south of current Chilean operations, suggest that as the Chilean longline fleet develops, they will eventually move into these offshore areas.

Japan: The Japanese conduct the largest eastern Pacific longline fishery (appendix E5 and figure 19). Japanese effort in the southeastern Pacific appears to be primarily in oceanic water at tropical latitudes.[384] They report good swordfish catches in two primary eastern Pacific fishing areas. The largest area is tropical waters well out into the ETP.[385] There is a smaller area of good catches closer to the coast, primarily off Peru, but extending to latitudes off northern Chile (20-25°S) and smaller catches as far south as 35°S. The high yields off Peru extend out to 90°W, but only 85°W off northern Chile. The Japanese report small catches out to 100°W and then at scattered locations further west. Catches are, however, much more extensive in the western Pacific off New Zealand and Australia and extend as far south as 50°S.[386] Japanese swordfish CPUE data on tuna longlining for a much longer period (1952-85) show that yields off Chile are highly seasonal (figures 10-11), but some high yields off northern Peru are reported from June-October (Peru, figure 10). Fishing at latitudes along

Photo 48 --A few Chilean longliners fish for swordfish in the south Atlantic out of Montevideo, Uruguay where the product is landed for transshipment. Dennis Weidner

the central coast is much more limited, but some high yields are noted as far south as 40°S during May (figure 11). The best fishing is usually relatively close to the coast, beyond the 200-mile limit. Rarely are good yields reported beyond 100°W.[387]

Korea: Korea has not reported significant swordfish catches in the southeastern Pacific (appendix E5 and figure 19). Overall longline activity was as follows: virtually no activity in the southeastern Pacific (1988), no activity in the southeastern Pacific (1989), but some activity off southern Peru and northern Chile (85-90°W during 1990 and 75-95°W during 1991 and 80-95°W during 1992).[388]

Spain: The Spanish appear to be fishing off northern and central Chile at latitudes of 18-43°S. They operate somewhat to the south and further from the coast than the Chilean fleet, although seasonally the Spanish move closer to the coast and there is substantial interaction between the fishermen. Operations at these latitudes are roughly confirmed by available Chilean Navy reports of port calls (appendix D4). The larger Spanish vessels are able to withstand the rough sea conditions at the southern latitudes (photo 47). Operations are conducted year round. They begin at the southern range of the fishery at the beginning of the year and gradually move north as the season progresses. The Spanish fish outside Chile's 200-mile zone. Some observers report they are fishing beyond 84°W during much of the year. This would mean a distance of about 1,300 km off the coast.[389] Other sources suggest that the Spanish are not operating quite so far out into the Pacific, but at least 650 km from the coast.[390] During the Chilean winter (July through September), the Spanish often move closer to the coast and fish up to the 200-mile limit.[391] It is during this period that there is considerable contact between the Spanish and Chilean fishermen.

Taiwan: Taiwan fishermen are not active in the eastern Pacific off South America. Data for 1992, for example, shows no fishing anywhere in the eastern Pacific east of 110°W. There is, however, extensive activity in the Atlantic off South America.[392]

United States: The U.S. swordfish longline fleet is primarily deployed out of Honolulu on grounds north of the islands. An occasional U.S. longliner has operated in the eastern Pacific. Few details are available on the grounds, but they have reportedly fished at latitudes off Chile.[393]

2. South Atlantic

A few Chilean longliners are also being deployed in the south Atlantic.[394] The authors have very little information, however, on Chilean Atlantic operations. The vessels are deployed for both toothfish in sub-Antarctic waters and swordfish to the north out of Montevideo (photo 48).[395] One of the companies involved is Pesquera Omega which seasonally operates the longliner *Tami-S* out of Montevideo. The vessel does not have an Uruguayan fishing license and therefore fishes outside of the Uruguayan 200-mile zone. The vessel was reportedly landing 70-95 t of swordfish on trips of about 35 days during 1995.[396] The catch is reported to SERNAP for inclusion in Chilean catch statistics.[397] The authors do not know of any other Chilean companies directly involved in Atlantic operations, although Pesca Chile is indirectly involved because of its association with Pescanova--the large Spanish fishing company. Grupo Pescanova has affiliates in both Uruguay and Chile. The Chilean affiliate (Pesca Chile) recently transferred two longliners (*Pesca Chile* and *Lerez*) to the Uruguayan affiliate (Pesquerías Belnova) for swordfish operations.[398] Interestingly, Pesca Chile does not target swordfish, unlike Belnova which does. Pesca Chile does, however, target Patagonian toothfish in its Atlantic longline operations.

IV. Fleet

Chilean fishermen operate the largest swordfish fleet in Latin America. Government financial incentives enabled many artisanal fishermen to purchase vessels during the 1980s. A substantial number of those fishermen were attracted to the swordfish fishery because of the high yields, availability of efficient fishing gear and methods, and lucrative export sales. Commercial fishermen soon followed suit. As a result, the fishery expanded rapidly during the late 1980s. (See "Catch.")

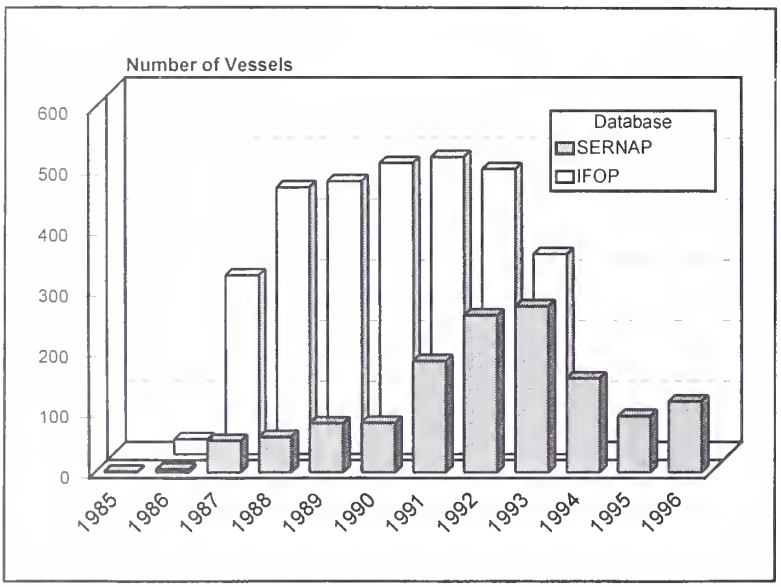

Figure 73.--Data on the swordfish fleet varies, but all observers report that large numbers of vessels have withdrawn from the fishery.

The authors have collected widely varying estimates of the artisanal and commercial swordfish fleet. Estimates have varied as high as 1,000 vessels at the peak of the fishery, other estimates are only about 275 vessels. While different observers report widely varying estimates on the absolute number of vessels, the trends indicated are more consistent, but not identical. IFOP and SERNAP data appears to differ significantly. Given the fact that several IFOP researchers have closely followed the swordfish fishery, the IFOP data may be more accurate.

SERNAP: The SERNAP data is a print out of available data from a data base not designed to reveal fleet size by species (appendix A2b2 and figure 73).[399] SERNAP officials stress that there current data collection system focuses on the product landed more than the vessels deployed in the fishery. Thus existing data may not provide an accurate assessment of the swordfish fleet, especially in the early days of the fishery. The accuracy of the data improved after 1993 when the artisanal registry was introduced.[400]

IFOP: IFOP reports that the artisanal fleet commenced significant operations in 1986 with only about 25 vessels. A few commercial vessels reported operations in 1987. The fleet expanded rapidly to about 450 vessels by 1989 (appendix A2b1 and figure 73). Concerned with this rapid expansion, the SSP decided in 1990 that government action to manage the fishery was required. (See "Government Agencies and Policy.") The number of vessels peaked at nearly 500 vessels in 1991.[401] SERNAP closed the fishery to new entrants in 1991.[402] A substantial number of fishermen as a result of declining yields reportedly withdrew their vessels from the fishery during 1993 and 1994, although local observers provide varying assessments.

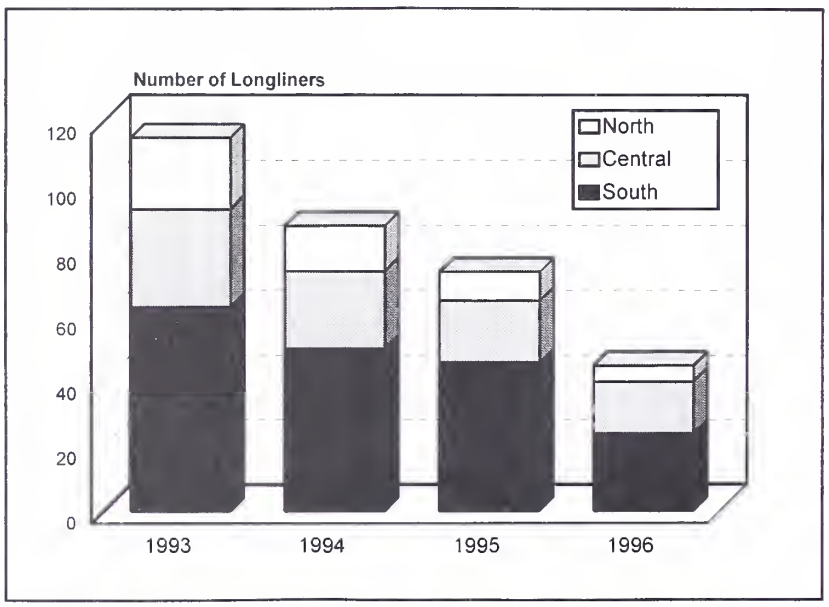

Figure 74--Commercial longliners, many of which are deployed for swordfish (north/central), have also declined since 1993--despite the catch increase reported in 1996.

IFOP reported 285 artisanal vessels were active and another observer reported only about 140 vessels in 1994 (appendices A2b1 and A2b3 and figure 73).

Photo 49.--Chile's artisanal swordfish fleet has declined substantially from the peak of the fishery in 1991. Dennis Weidner.

Both the commercial and artisanal fleets have clearly declined sharply, despite the differing statistical estimates on fleet size (photo 49). The most recent report from SERNAP indicates that the swordfish fleet reached a low of 93 vessels in 1995, but recovered to 117 vessels in 1996 (appendix A2b2). The SERNAP data has generally shown a much smaller number of vessels participating in the fishery than the IFOP data. The general pattern of rapid fleet buildup of the fleet during the early 1990s and then sharp decline is similar, but not identical to the pattern shown by IFOP. Notably the SERNAP data reports a substantial increase in the artisanal fleet during 1996, despite the catch decline. (See "Catch".) The authors can not explain the discrepancies between the IFOP/SERNAP data sets, but the number of vessels has clearly declined.

Recent fluctuations in the commercial fleet are particularly interesting, given its importance during 1996. SERNAP reports that the overall commercial fleet continued to decline declined to only 32 vessels in 1996. The number of large commercial longliners targeting swordfish out of San Antonio and Coquimbo (north) has declined from about 22 in 1993 to only 9 in 1995 and 5 in 1996, although a few smaller longliners were also active out of Constitución (central) (appendices A3b-d and figure 74).[403] This downward trend reported by SERNAP is in sharp contrast to the significant increase in the commercial catch reported in 1996 (appendix E2f and figure 63). Most of the commercial catch and virtually all of the catch beyond 200-miles is taken by longliners. Apparently the longliners remaining in the fishery had a spectacular 1996 season.

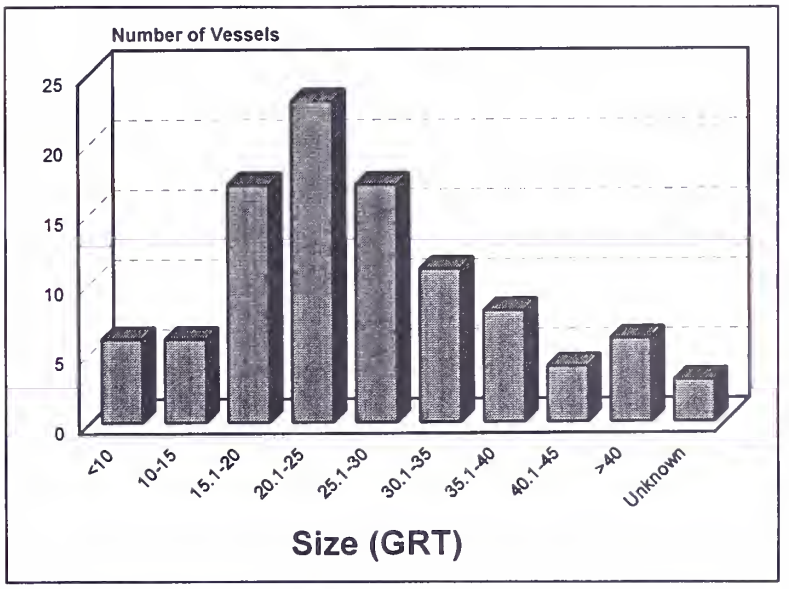

Figure 75.--Most of the Chilean swordfish fleet ranges from 15-40 GRT.

Chilean fishermen operate both artisanal and commercial fleets. As a result, vessels of widely different characteristics are involved in the fishery. Various reports published from 1990-92, at the peak of the fishery, provided details on vessel characteristics. Given the number of vessels withdrawn from the fishery, however, the composition of the fleet may have changed. The decline of the artisanal fishery in 1996 (appendix E2f and figure

63), appears to reflect a decision by many small boat operators to withdraw from the fishery, at least temporarily.

Tonnage: Fishermen have been steadily increasing the size of their vessels (appendix A4b). Even so, through 1995 much of the Chilean fleet continued to be fairly small vessels. Most vessels (80 percent) in 1991 were only 35 GRT or less (appendix A2e and figure 75). Only a small number of vessels (about 20 percent) exceeded 35 GRT. The artisanal vessels averaged about 27 GRT (appendix A4b).

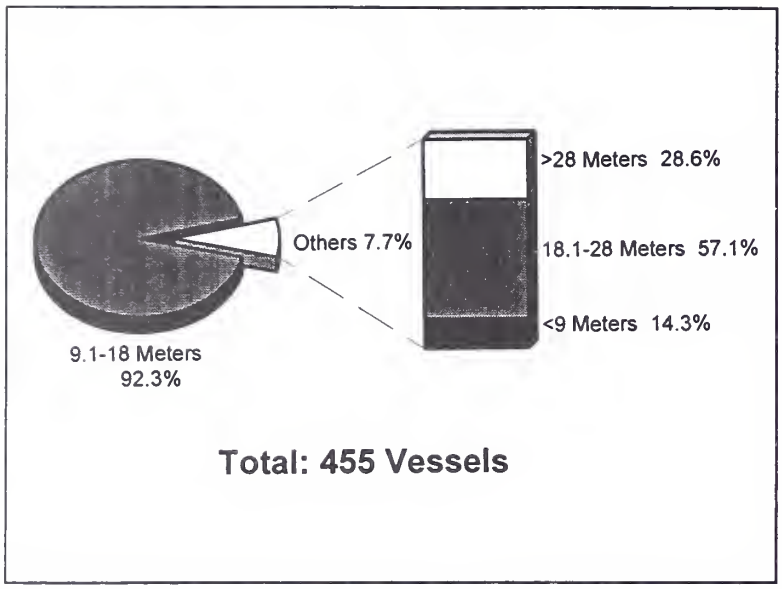

Figure 76.--Most of the artisanal swordfish fleet is vessels from 9-18 meters.

Length: Most of the Chilean artisanal vessels are from 9-18 m in length (appendices A2e-f and figure 76). They average over 15 m (appendix A4b). Only about 30 larger vessels were deployed in 1991, 10 of which were longer than 28 meters. These larger vessels, mostly longliners, are operated by commercial fishermen (photo 50).

Range: Data on the range of the vessels is unavailable. Given the small size of most vessels, the range appears to be limited. Declining yields have, however, forced the fishermen to make longer trips, well off the coast. The small artisanal vessels are not capable of distant-water operations (photo 51).[404] Chile does have a substantial longline fleet (appendix A3a), but only a few of those vessels are currently deployed for swordfish (appendices A3b and d and figure 74). These vessels include several commercial longliners capable of distant-water operations.

Hulls: The vessels have hulls of different material, but primarily wood: wood (77 percent), steel (20 percent), fiberglass (2 percent), and ferrocement (1 percent).[405] Most of the larger vessels have steel hulls.

Horsepower: Most Chilean vessels in 1991 have engines ranging from 41-200 horsepower (appendix A2e and figure 77).

Type: Chilean fishermen employ three basic vessel types. Traditional fishermen operated small open boats ("bongos" and "faluchos") using harpoons, but only a few are now used occasionally for swordfish (photo 52). More advanced artisanal and some commercial fishermen operate a wide variety of vessels ("lanchas") to deploy driftnets (photo 51). A few companies operate commercial longliners, the largest vessels in the Chilean driftnet fleet (photo 53).

The importance of the artisanal and commercial fleets has varied from year to year. Generally the artisanal fishermen have dominated the fishery. The declining yields and the apparent depletion of inshore waters has adversely affected the artisanal fishermen. The great bulk of the catch in 1996 was landed by the commercial fishermen.

1985-90: The current fishery was initiated by artisanal fishermen who in the mid 1980s began replacing harpoons with driftnets. Catches began reaching significant levels during 1985-86 (appendix

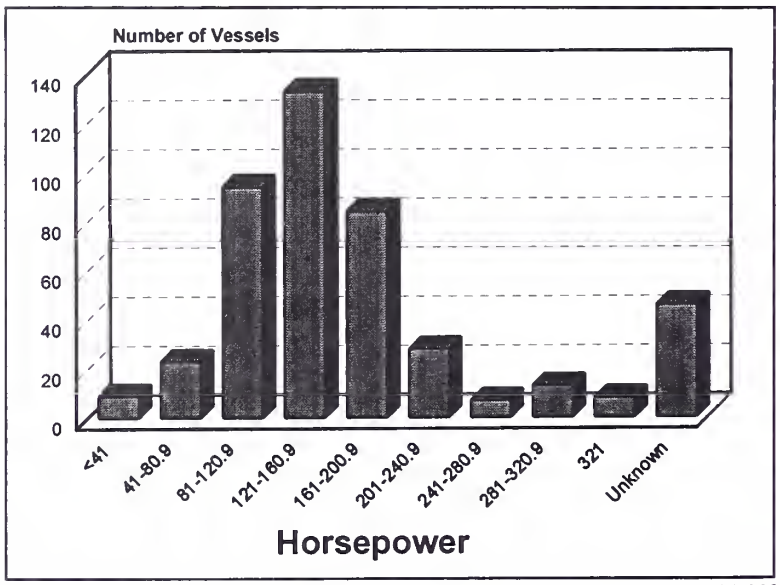

Figure 77.--Artisanal vessels used in the swordfish fleet have engines from 81-200 horsepower.

Photo 50.--Artisanal fishermen dominated the swordfish fishery for several years, but in 1996, the commercial longline fishermen landed most of the catch. Dennis Weidner.

E2a1 and figure 91). The artisanal fishermen landed the entire catch in 1986 and dominated the fishery through 1990. The first meaningful commercial catches were reported in 1987 when the artisanal catch fell to 90 percent (appendix E2f and figure 63). The commercial fishermen introduced longliners in 1989, after which their catch increased sharply.

1991-92: Commercial fishermen rapidly expanded their operations and acquired additional vessels. The overall swordfish catch peaked at 7,300 t in 1991, about 55 percent of which was taken by the commercial fishermen (appendix E2f and figure 63). The catch declined somewhat to only 6,400 t in 1992, but the commercial fishermen continued to take more than half the catch.

1993-95: Declining catches after 1991 and even more so after 1992 caused many companies to withdraw their longliners deployed within the 200-mile zone (appendix E4a1 and figure 78). As a result, the commercial catch declined steadily after 1992. The large longliners, which require a substantial initial investment, proved very expensive to operate. The companies involved were thus more seriously affected than the artisanal fishermen operating small driftnet vessels with lower overhead. Even so, a substantial number of artisanal fishermen also withdrew their vessels from the fishery (appendix A4a and figure 76). Several companies began to use the expensive freezer longliners to land fresh fish. Artisanal fishermen landed nearly 60 percent of the 4,700 t catch in 1993 and by 1995 were taking more than 80 percent of the reduced 2,600 t catch (appendix E2f and figure 63).

1996: The situation changed radically in 1996. The apparent shift west of the resource operated against the artisanal fishermen. Many of their vessels are not capable of offshore operations. In addition, the decline of the coastal fishery and the need to fish further off the coast raised operating costs in some cases beyond the value of the catch. In addition, prices for more easily accessible demersal species were strong.[406] The commercial fishermen in their large vessels were capable of moving to the better yielding offshore grounds (photo 53).

Photo 51.--The small size of the artisanal vessels limits their range and has affected operations as the fishery seems to be shifting west. Dennis Weidner.

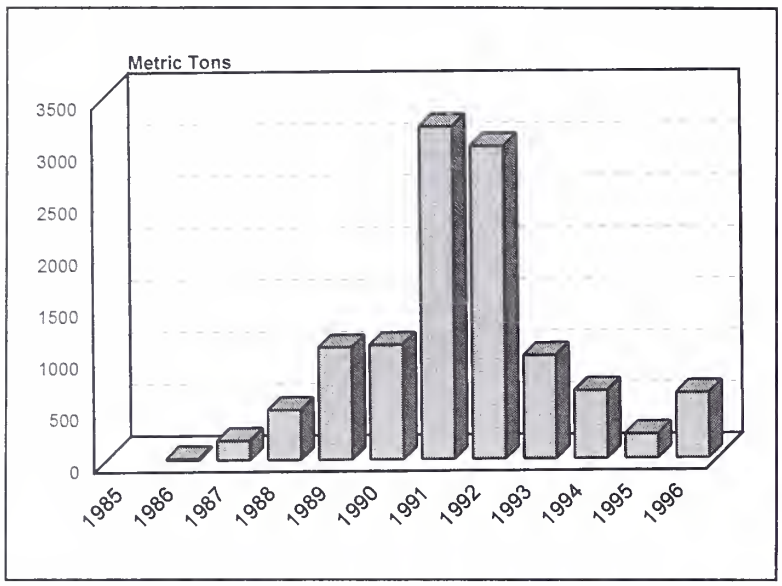

Figure 78.--After 1991-92, the commercial catch taken within the 200-mile EEZ dropped precipitously, but recovered slightly in 1996.

All of the longliners shifted primarily to the more valuable fresh product. As a result, commercial catches escalated, reporting the first catch increase since 1991. The commercial fishery totaled 80 percent of the 3,100 t 1996 catch, virtually replacing artisanal landings. Much of the commercial landings taken outside 200-miles are landed at Coquimbo.[407]

1997: Preliminary reports suggest that the commercial fishermen continue to land the bulk of the catch, although the artisanal fishermen are landing much larger catches than they did in 1996. (See "Catches.")

Several artisanal fishermen who left the fishery in 1996, redeployed their vessels for swordfish in 1997. The commercial catch continued to be landed by a small number of vessels.

Limited economic data is available on the profitability of Chilean swordfish vessels. A economic analysis prepared by IFOP suggests that the fishery is no longer profitable for new entrants. Current fishermen remain in the fishery only because they have already amortized the cost of their vessel.

Artisanal vessels: Some observers report that the artisanal vessels are finding it more difficult to compete with the commercial vessels. The increasing distance from the coast where the fishery is conducted puts the artisanal fishermen with small vessels at a disadvantage. (See "Fishing Grounds.") Despite these problems, artisanal fishermen in the early and mid-1990s continued operating. IFOP reported, however, that the fishery was no longer profitable for new entrants, given the declining yields and interest rates.[408] The artisanal fishermen during 1993-95 landed an increasing share of a diminishing catch (appendix E2f and figure 63). The artisanal fishermen in 1996, however, reported a disastrous year with many withdrawing from the fishery. The authors believe that the major problem is the apparent shift west of the fish. (See "Species: Distribution".)

Commercial: Commercial fishermen have also encountered problems and many withdrew from the fishery after 1992. The higher initial investment in longliners may have been a mistake for some companies as few currently appear to be using the freezers and cold storage equipment to freeze the catch. The larger longliners do enable the commercial fishermen to target distant-water grounds beyond the range of

Photo 52.--Small open boats were once used for harpooning swordfish, but currently are only used occasionally by a small number of part-time fishermen.

Photo 53.--Chilean companies have imported several modern longliners equipped with freezers and capable of extended voyages.

the artisanal fishermen. (See "Fishing Grounds.") The profitability of these distant-water grounds is unclear. Some reports suggest that yields have declined sharply.[409] The authors have, however, been unable to obtain time-line data on the yields of the commercial fleet. The sharp decline in the number of commercial longliners is evidence of the difficulties that the commercial fishermen have encountered (appendix A3d and figure 74). Some companies, however, are reporting profitable operations (photo 53). In addition, the spectacular results reported in 1996 suggest that those longline fishermen remaining in the fishery achieved excellent results. Rising prices for fresh fish in 1995-96 may be another key factor (appendices G4a and J2h1 and figures 94 and 150).

The various fishing methods require some special features for the vessels employing them:

Harpoons: Artisanal vessels used for a directed harpoon fishery are primarily bongos and lanchas equipped with a steel structure at the bow of the boat ("tangón") to provide a platform for the harpooner to get a clear strike at the fish (photo 54).

Drift gillnets: Most of the driftnet vessels are not purpose-built vessels, but rather multi-purpose vessels which can be used in several different fisheries. As a result, they have few features specifically related to driftnet fishing. The principal requirement is that the vessels need to be big enough to carry the net as some are quite large (photo 51). Some of the vessels have hydraulic systems to retrieve the net, but many still bring in the net by hand. The vessels are equipped with ice holds which limit even the largest vessels to trips under about 20 days because of the need to land even well-iced fresh fish. Some of the vessels have a detachable "tangón" on the bow of the boat so that occasional swordfish encountered basking at the surface can be harpooned (photo 55). The tangón is removed after the season ends. The fishermen then re-rig the vessels to shift to other fisheries such as longlining for high quality groundfish (often referred to as "bacalao" in Chile[410]), trawling for hake, or even seining for pelagic species.[411]

Longlines: The largest swordfish vessels in the Chilean fleet are longliners deployed in the commercial fishery. The longliners are purpose-built boats with a variety of special features. Many have hydraulic equipment for setting and retrieving the line. Most have areas at the stern, sometimes enclosed, where the crew deploys the baited hooks and line (photo 56). Some longliners have metal plates at the bow which spin to retrieve the line.[412] The vessels are equipped with freezers and are capable of trips up to about 2 months in duration. Chilean companies have operated these vessels as much as 1,300 km out into the Pacific Ocean, but several are capable of even more extended trips. As the prices and profitability for frozen product has declined (appendices G4a and J2f3 and figure 94), most of these vessels (especially since 1996) have been used for shorter trips allowing them to land more valuable fresh product.[413] The freezer capability of these vessels is not currently being used.

A. Artisanal

The rising international demand for swordfish and the efficiency of newly available monofilament driftnets attracted many new entrants to the swordfish fishery during the mid-1980s. A Government loan program helped artisanal fishermen buy vessels during the mid-1980s. (See "Government Agencies and Policies.") Many of these fishermen decided to

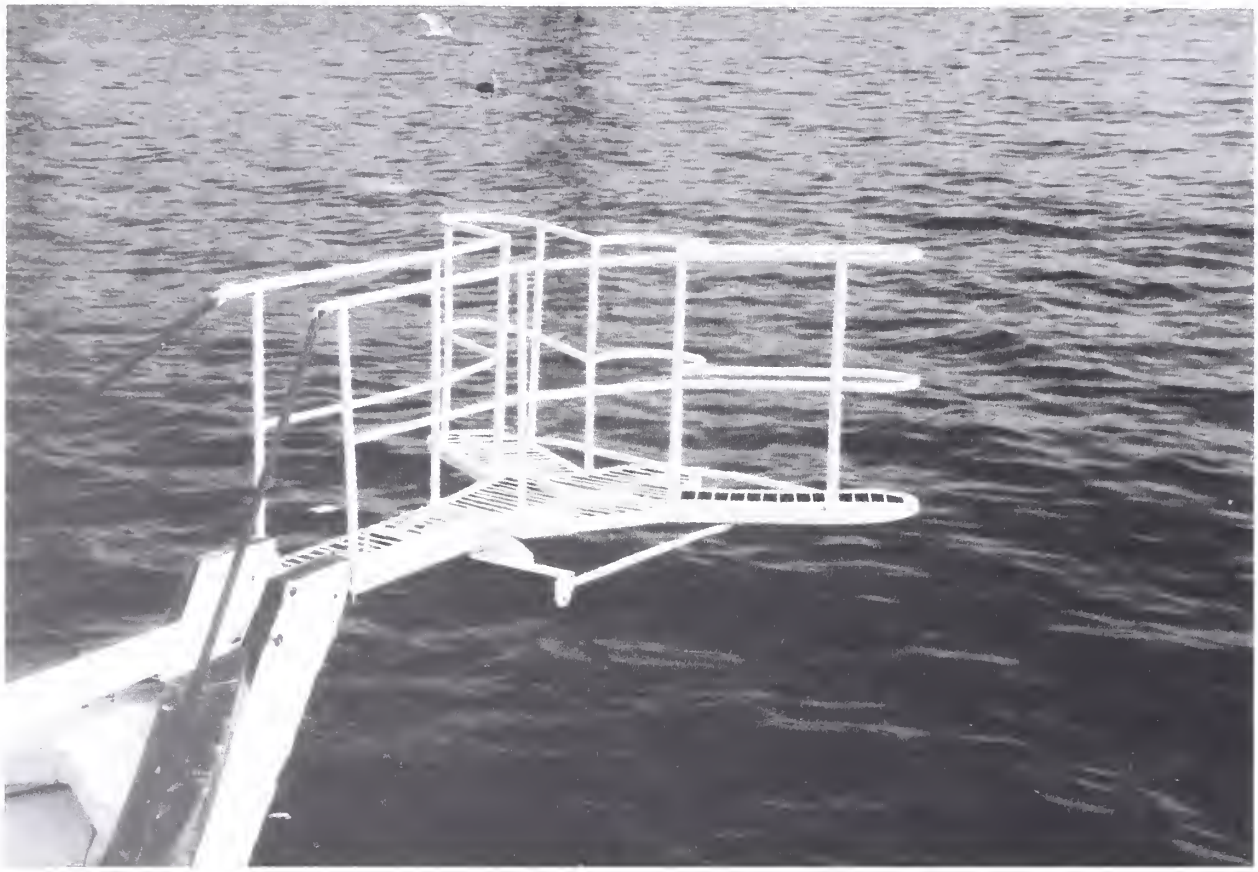

Photo 54.--A "tangon" or harpoon platform is attached to the bow of many vessels. Dennis Weidner.

Photo 55.--Lanchas deploying mostly driftnets, but also a few longlines, constitute the bulk of the artisanal fleet. Dennis Weidner

Photo 56.--Some commercial longliners have enclosed areas to permit fishermen to deploy the main line and baited hooks even in rough weather. Dennis Weidner.

deploy their new vessels in the swordfish fishery. The artisanal swordfish fleet exploded from only about 25 vessels in 1986 to nearly 300 vessels by 1987.[414] The artisanal fleet peaked at about 515 vessels in 1990 (appendix A4a and figure 79), but actual fishing power increased even more. Many fishermen during this period acquired larger vessels, increasing the length, power, and tonnage (appendix A4b).[415] The larger vessels greatly expanded the capability of the fleet enabling them to target previously unexploited offshore grounds as well as to stay on the grounds fishing for longer periods and in rougher weather conditions. The fishermen also improved their gear and perfected their fishing methods. After the fishery peaked in 1991, many fishermen began shifting to alternative species because of declining yields. (See "Species: Yields.") The fleet declined sharply in 1993 and 1994. Only about 275 vessels were active in 1994 (appendix A4a and figure 79).[416] The authors have less detailed current statistics, but anecdotal accounts suggest that the fleet may have fallen to 120 small boats in 1995 and probably less than 100 in 1996.

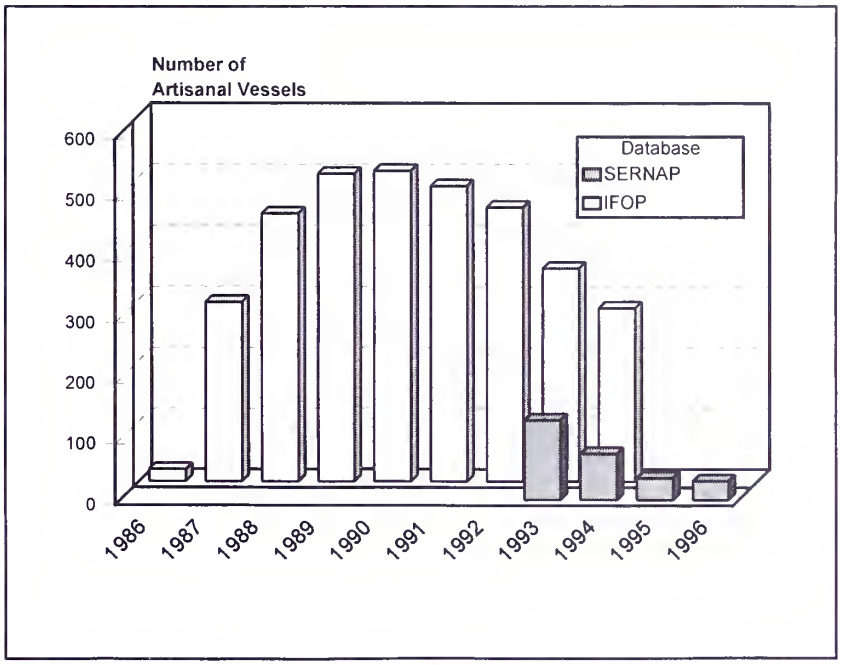

Figure 79.--Statistics vary, but the artisanal swordfish fleet peaked in 1990 at nearly 500 vessels. Many have since switched to alternative fisheries.

The artisanal vessels range up to 18 m (most are from 7-18 m), but can not exceed 50 GRT.[417] The artisanal fishermen primarily deploy two general categories of craft ("bongos"/"faluchos" and "lanchas"). The bongos and faluchos are traditional small-scale artisanal vessels relying on harpoons and are gradually disappearing from the swordfish fishery. The lanchas, however, primarily deploy driftnets and during the early 1990s dominated the artisanal fleet (appendix A2f and figure 80). The larger lanchas are really conducting commercially oriented operations. The basic difference between the artisanal lanchas and the commercial driftnet vessels is the size of the vessel. Artisanal lanchas are vessels up to 18 m and 50 GRT. The bongos/

Photo 57.--A few bongas also have tangones attached to help the harpooners get a good strike at the fish. Dennis Weidner.

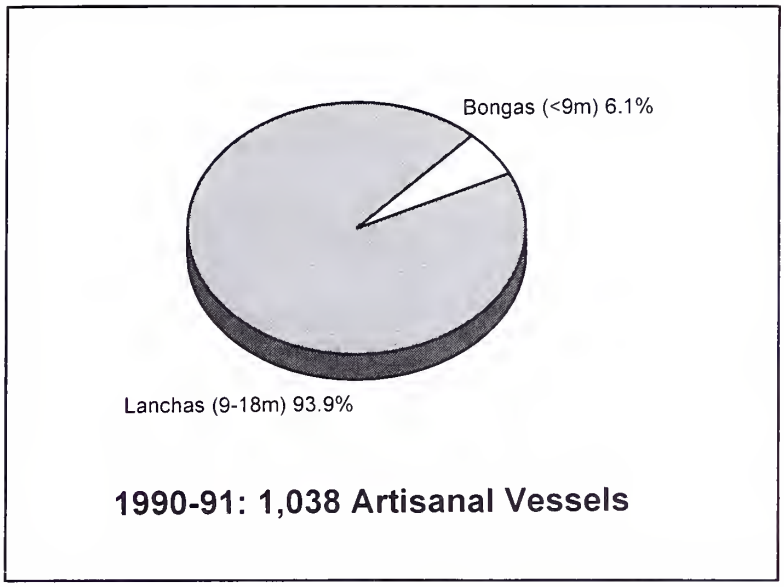

Figure 80--Some estimates of the artisanal swordfish fleet exceeded 1,000 vessels, most of which were "lanchas."

faluchos and the smaller lanchas are unable to follow the fishery moving north along the coast as the season progress. The smaller boats are mostly limited to operations relatively close to their home ports. The larger artisanal lanchas and commercial driftnet vessels conduct similar fishing operations, although the commercial vessels are prohibited from operating in coastal waters. (See "Government Agencies and Policies.")

Bongos: Fishermen currently use an open-decked boat, called a bongo, which can be up to 9 m in length. Most are 7-9 m in length (photo 52).[418] The smallest are basically large dories with outboard motors. There is no hold or system to maintain the quality of the catch.[419] These were the primary vessel type used by the fishermen to conduct the harpoon fishery which was active during the 1930s-50s, although they were commonly only 5-6 m in length, smaller then the bongos currently in use. Sailboats were gradually replaced with small 5 hp motors which until the 1960s were often unreliable forcing many of these fishermen to frequently resort to sails.[420] The fishermen when bearing down on a swordfish would also employ oars. The fishermen use harpoons with these small boats. Large numbers of bongos are still active, but they are mostly deployed for other fisheries. Tangones can be found on the bows of some boats (photo 57). The fishermen involve take only small numbers of swordfish, primarily as an opportunistic catch.

Faluchos: The faluchos are slightly larger than the bongos, mostly from 9-12 m long. They also lack any holds, but most of the motors are inboard.[421] Some of these vessels were operated as mother ships, leaving pairs of fishermen at sea to tend the catch from balsa rafts.[422]

Lanchas: A substantial fleet of artisanal lanchas target swordfish, mostly with drift gillnets. At the peak of the fishery in the late 1980s and early 1990s a very large number of artisanal lanchas were deployed for swordfish during at least part of the year (photos 51 and 55). Estimates range from 500-1,000 (appendices A2f and A4a and figure 79). As the catch has declined in recent years, the number of lanchas has declined, although the authors have received widely varying accounts. One report suggested about 275 vessels in 1994, still a substantial fleet.[423] IFOP reports indicate that the artisanal fleet fell to only 286 boats in 1995 (appendix A4a and figure 79).[424] The authors are unable to resolve the discrepancies between the available data, but it is clear that the number of artisanal boats has declined sharply from the early 1990s. Given the sharply lower 1996 artisanal catch (appendix E2a1 and figure 64), this decline has almost certainly continued. Various local observers report that many fishermen redeployed, at least temporarily, for other species in 1996.[425] The lanchas used for driftnetting are mostly not purpose-built vessels. Most are multi-purpose vessels which can be rigged for various fisheries. Many are older vessels that are rigged for seasonal swordfish driftnet operations and then redeployed in other fisheries when the season ends. Artisanal fishermen deploy lanchas ranging from 9-18 meters, although they average about 15 m and approximately 50 GRT. These vessels, especially the advanced artisanal lanchas, make up the great bulk of the Chilean fleet in terms of number of vessels (appendix A2f). The fishermen mostly deploy driftnets of up to 1.8 km in length. (See: "Gear and Fleet Operations" for details on gear.) Most of the artisanal vessels are operated by individuals who have worked as crew members or inherited their vessels. Approximately 500 driftnet, mostly artisanal, vessels were registered for swordfish operations during 1988-95, but probably no more than 200-300 were deployed at any given time, and then for only part of the year during the season. The number of vessels has declined sharply after 1993 (appendices A2b1 and 3 and figure 73).[426] There are two classes of artisanal lanchas:[427]

Traditional: The small traditional lanchas range from 9-12 meters. These wooden-hulled vessels have mostly been converted from traditional artisanal vessels previously deployed in other fisheries. They generally have only minimal decks. Many use

harpoons as an alternative gear on a opportunistic basis to supplement driftnet operations. These boats are built by carpenters and shipwrights in artisanal yards.

Advanced: There is quite a variety of vessels making up the advanced artisanal fleet. Most have wooden hulls, but several have hulls made of other materials as well. As the fishery developed during the 1980s, the fishermen have increasingly shifted to vessels of 15 m or larger when ordering new or replacement vessels.[428]

Wood hulls: The vessels are similar in design to the smaller traditional vessels. They are also mostly built by carpenters in artisanal yards. They primarily are equipped with driftnets, but many are rigged with detachable platforms ("tangones") for opportunistic harpooning. A few are equipped for longlining.

Other hulls: Other vessels (steel, fiberglass, or ferrocement hulls) are built in commercial shipyards. They have more elaborate decking and navigational and communication equipment. Some of these vessels are operated more as commercial vessels and are owned by companies.

B. Commercial

The commercial ("industrial") fleet of larger vessels makes up a relatively small part of the overall fleet, although they make a major contribution to the catch.[429] The size of the commercial fleet has fluctuated widely since the first longliner was deployed in 1991.

1987-88: The first significant commercial fishing was reported in 1987. The fishermen initially deployed driftnet vessels.

1989-92: Commercial fishermen deployed the first longliner in 1989 and rapidly expanded the fleet, although the authors do not have detailed time-line data. The commercial fishermen by 1991 were landing more than half the swordfish catch (appendix E2f and figure 63).

1993-95: IFOP and SERNAP reports indicate that the commercial fleet declined sharply after 1992, although it is difficult to determine the actual extent of the decline because of limited and conflicting data (appendix A3d and figure 74). The fleet has clearly declined since 1992.[430] One source reported 14 longliners in 1994, but only 6 in 1995.[431] The commercial catch declined to less than 20 percent of the catch (appendix E2f and figure 63).

1996: Only about 5 longliners (almost certainly targeting swordfish) were registered by SERNAP from northern ports in 1996, although some Constitución (Region VII) longliners were also active (appendix A3d and figure 74).[432] Some companies also operated a few driftnet vessels. Despite the small number of longliners, the commercial catch, especially the catch outside 200-miles, exploded in 1996 to 80 percent of the country's swordfish catch (appendix E2f and figure 74).

There are two classes of commercial vessels, medium and large vessels. The commercial vessels vary from about 21-62 m, although SERNAP considers all vessels exceeding 18 m to be commercial vessels.[433] Most have radar, satellite navigational equipment, video plotters, and color echosounders. Details on the different types of commercial vessels deployed in the swordfish fishery are:

Medium: The medium-sized commercial vessels vary from 18-28 meters (appendix A2f and figure 81). Many of these vessels are relatively new, recently built in domestic shipyards--mostly with steel hulls. Most of these vessels are not purpose-built for swordfish, but rather for groundfish bottom longlining. Several were shifted to swordfish in the early 1990s.[434] They are all decked vessels with sophisticated navigational and fish finding equipment. The vessels are capable of using varied gear. Most use driftnets for swordfish, about the same size nets as used by the advanced artisanal vessels. A few are rigged for longlining.

Large: The larger vessels range from 28-73 m, although one vessel is 92 meters (appendix A2f and figure 81).

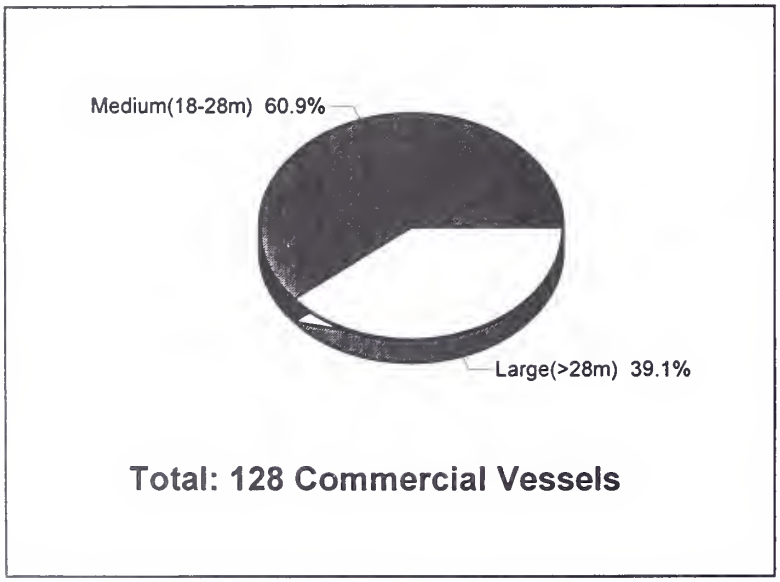

Figure 81.--Nearly two-thirds of the commercial fleet during the early 1990s was relatively small boats, mostly longliners.

As mentioned above, SERNAP requires that these vessels operate at least 120 miles offshore to reserve coastal fishing to the artisanal fishermen. (See "Government Agencies and Policies.") The larger commercial vessels are better equipped to operate on the offshore grounds (photos 53 and 56). Some of these vessels employ large driftnets (as large as 2.4 km), but most use longlines (mostly 1,200-1,600 hooks). (See: "Gear and Fleet Operations.") These larger vessels are less diverse than the medium-sized commercial vessels. Many are imported vessels, originally built for tuna longlining (appendix A3c). All of these vessels are owned and operated by fishing companies.

C. Recreational

Chile currently has no organized marine recreational fishery and no appreciable recreational fishing fleet. There are a few marinas and yacht clubs for pleasure boats, but most of the vessels are sailboats. A few clubs are active and in some areas artisanal fishermen may offer their boats for hire during the tourist season.[435] The larger marinas are primarily located in the coastal area around Valparaíso and Viña del Mar. This is the coastal area closest to the large Santiago metropolitan area where more than a third of all Chileans live. One of the largest marinas is at Algarrobo, a beach resort about 75 km south of Valparaíso (photo 58). There was some Chilean sport fishing in the 1930-50s, but for unknown reasons this appears to have largely ended during the mid-1950s.[436] Chilean boat owners do not currently engage in extensive organized marine recreational fishing, but there are a few fishing clubs. No regular party boat services are known to be available anywhere in Chile, but some recreational fishermen informally make their vessels available in tourist areas.[437] Government officials believe that Chile may have the potential for a marine recreational fishery and are currently assessing it.[438]

***Photo 58**.--Big game fishing is currently rare off Chile. One U.S. sport fisherman reported good swordfish catches out of Algarrobo during the late 1980s. Dennis Weidner.*

V. Shipyards

Chilean fishermen have acquired their vessels from both domestic and foreign sources. The artisanal fishermen have generally obtained their vessels for driftnetting from local shipwrights or bought used boats and rigged them for driftnetting. The boats used for driftnet fishing are mostly multi-purpose craft. The commercial fishing companies have largely imported their longliners.

A. Vessel construction

Chilean artisanal fishermen have obtained their vessels from local shipwrights and small shipyards. Most are multi-purpose vessels which are rigged seasonally to deploy driftnets. The large commercial shipyards have built relatively few vessels for the fishery. Some shipyards, however, have purpose built a few driftnet and longline vessels.

Shipwrights/Artisanal yards: Most of the country's artisanal vessels have been built domestically by shipwrights and small shipyards. The small "bongos" and "faluchos" are built by local shipwrights and carpenters. The artisanal vessels used for driftnetting have mostly been built in small artisanal yards specializing in wooden-hulled vessels. Several such yards are located at ports all along the Chilean coast. In San Antonio small yards such as Astillero Mario Pecisce and Puertecito de San Antonio build and repair these vessels (photo 59).[439] Most of the major ports along the central coast have similar yards servicing the artisanal fleet, including the swordfish driftnet vessels.

Commercial shipyards: Chile has some of the most sophisticated shipyards in Latin America. The commercial yards have built a number of small boats to deploy driftnets for artisanal fishermen. Marco, for example, launched the 15-m *Andrea* in 1988 as the fishery was developing. The new vessel was designed to deploy driftnets for swordfish.[440] Chilean yards are also capable of building large commercial vessels. Several yards specialize in fishing boats and vessels exceeding 1,500 tons have been constructed for the country's massive small pelagic fishery.[441] More recently ASMAR has constructed a 1,800 GRT vessel.[442] Several shipyards are preparing to build even larger vessels. Marco has prepared preliminary designs for massive vessels (2,100-2,500 cubic meters) and at least one company has expressed an interest in these large vessels.[443] Chile's three large shipyards (Astilleros y Servicios Navales--ASENAV, Astilleros y Maestranzas de la Armada--ASMAR, and Astilleros Marco Chilena) are quite capable of building even the largest longliners currently used by the commercial fishermen (photo 60). The largest Chilean longliner currently deployed is the 795-GRT *Frio Sur V*, and vessels of this size are well within the capabilities of these three major Chilean shipyards. Chilean yards have built a few small longliners. One of the first was the *Elva S*, built by Marco in 1988 for Pesquera Omega.[444]

The Chilean shipyards, however, have given relatively little attention to longliners and instead specialize primarily in seiners to support the country's massive purse seine fishery for small pelagic species (photo 60). The Chilean yards also have considerable

Photo 59.--Several small shipyards, like this one in San Antonio, service artisanal and small commercial vessels. Dennis Weidner.

Photo 60.--Chilean shipyards like ASMAR primarily build seiners for the country's small pelagic fishery and have little experience with longliners. Dennis Weidner.

experience with trawlers. There has, however, been some activity. Chilean yards have apparently decided that the domestic market is too small to justify the expense of developing an expertise in longline construction--especially as older Asian longliners are currently available at relatively attractive prices.[445] The vessels known to the authors are all small vessels under 90 GRT (appendix A5). The authors do not have a complete inventory of activities at Chilean yards, but some limited information is available on the construction of a few small longliners:

Marco: Marco Chilena is one of Chile's principal shipyards with facilities in several ports (photo 44). Marco has built 18-m multipurpose vessel suitable for longlining and driftnetting.[446]

ASMAR: ASMAR is the Naval shipyard in Valparaíso (photo 60). It has built a few longliners, including the 79 GRT *Pesca Chile Dos* and *Cuatro*, both small boats with ice holds.

Carpinteros de Ribera : This small Puerto Montt yard has built a 88 GRT wood-hulled combination vessel, *Olimpio*, which can deploy longlines (appendix A5).

B. Vessel imports

1. Multi-purpose vessels

Only a few of the multi-purpose vessels used for driftnetting, mostly the larger ones, have been imported. A few vessels have been imported from the Netherlands, Belgium, and other countries.[447]

2. Longliners

The Chilean longline fleet consists primarily of imported vessels. The longliners have been imported, mostly from Japan and Spain (appendix A3c).[448] Several other countries (Brazil, Germany, Italy, the Netherlands, Norway, and the United Kingdom) have provided smaller numbers of vessels. Most of the vessels were relatively old vessels, originally imported for other fisheries.[449] Interestingly, two of the most important longline fishing countries (Korea and Taiwan) have not supplied vessels to the Chilean longline fleet. This is in part because many of their longliners, especially the older vessels, were built in Japanese shipyards.

A substantial number of longliners were targeting swordfish in the early 1990s, but most of the fleet is currently deployed in groundfish fisheries off southern Chile (appendices A3b and d and figure 74). Several of the longliners being used for swordfish are the longliners built in Spain (*Curaco I, Niño de Corvo*, and *Talcan*), although full details on several of the vessels are unavailable (appendix A3b). The authors believe that a substantial portion of the longline fleet may have been imported as used vessels. A study of the Chilean fleet prepared by EDITEC, a publishing company specializing in economic and technical subjects--including the fishing industry, reports that most of the fleet is still owned by the original owner (appendix A3b). Other observers, however, insist that many of the vessels have been bought and sold as well as leased to various companies.[450]

Japanese vessels: The Japanese-built vessels are the larger longliners imported, averaging over 500 GRT and 45 m in length, substantially larger than the Spanish vessels. Chile's largest longliner is the 795-GRT Japanese-built *Friosur V*. The Japanese vessels are relatively old vessels, averaging about 21 years in 1994 (appendix A3c). The oldest vessel, the *Kofuku Maru*, was 30 years old in 1994. The newest Japanese vessel currently in the fleet is the *Mar Azul XV* built in 1977.

Spanish vessels: The Spanish-built longliners are substantially smaller than the Japanese-built vessels, averaging only about 370 GRT and less than 35 m in length (appendix A3c). Chile's largest Spanish-built longliner is the 753-GRT *Puerto Ballena*. Many of the Spanish-built boats are also relatively old, averaging 18 years in 1994--only slightly newer than the Japanese vessels. There are several rather old Spanish built vessels. The 216-GRT *Puerto Natales I* was built in 1958 and, as of 1994, was 36 years old. The fleet also includes several newer Spanish-built vessels imported during the late- and mid-1980s. These are the newest and most modern longliners in the Chilean fleet. These newer vessels have been imported by Empresa Pesquera Ficossa, Pesca Chile, Empresa del Estrecho, and Pesquera del Sur. Only Empresa del Estrecho, however, is using two of these newer vessels (*Curaco I* and *Talcan*) to target swordfish (photos 53 and 56).

C. Vessel services

Chilean shipyards are capable of servicing any of the driftnet and longline vessels currently comprising the domestic fleet. The shipyard industry is also capable of servicing large foreign distant-water fishing vessels. Several of the companies have advertized and received contracts from foreign companies. ASENAV in Punta Arenas has been particularly active and has managed to win contracts from foreign vessels operating in the Atlantic.[451] ASMAR with facilities in Punta Arenas, Talcahuano, and Valparaíso has reported foreign contacts.[452] The contracts, however, have not involved longliners participating in the tuna/swordfish longline fishery. For example ASMAR itself as well as its Spanish joint-venture, Sociedad Iberoamericana de Reparaciones Navales--SOCIBER, in 1993 reported contracts with companies in Croatia, Cyprus, Greece, Italy, Liberia, Panama, Peru, and the United States.[453] These contracts, however, did not involve fishing vessels, but primarily cargo vessels. Early reports in 1988, indicated that the ASMAR joint-venture in Punta Arenas (Astillero Estrecho de Magallanes-SAEM) with a South African company (Sandock Austral) did involve some fishing vessels.[454] It appears that most of the fishing vessel contracts are for vessels involved in the squid and groundfish fisheries in the south Atlantic off Argentina.[455] The Chilean yards appear to be more competitive than the Argentine, Brazilian, and Uruguayan yards located closer to the Atlantic fishing grounds.[456] Uruguayan yards based in Montevideo, however, have the advantage that the city is already a port of call for Spanish, Taiwan, and other foreign vessels transshipping their distant-water catch.[457]

VI. Gear and Fleet Operations

Gear and fleet operations for swordfish vary considerably between the artisanal and commercial fisheries.

Artisanal fleet: Artisanal fishermen currently deploy mostly driftnets for swordfish, although some may also take a few fish opportunistically with harpoons and a small number deploy longlines. A few small-scale fishermen still occasionally deploy small open boats for harpooning, but this now is only a part-time activity representing a minimal proportion of the catch. The artisanal fishermen conduct primarily coastal operations to land fresh fish, but are having to make increasingly longer trips. This appears to be significantly affecting their operations. Many fishermen withdrew their vessels from the fishery in the 1990s (appendix A4a and figure 79). The artisanal catch was relatively stable during 1992-94, but subsequently declined sharply, especially in 1996 to only 20 percent of the overall catch (appendix E2f and figure 63).

Commercial fleet: Commercial fishermen primarily deploy longlines, although some companies also operate a few driftnet vessels. The commercial fishermen with freezer vessels initially conducted offshore operations to produce frozen fish. The increasing disparity between prices for fresh and frozen product since 1993 (appendix G4a and figure 123), however, has caused the commercial longliners to now focus almost exclusively on fresh fish, despite the substantial investment in freezer vessels. The commercial fishermen report trips at considerable distances from the coast. Commercial fishermen significantly increased catches in 1996. The fishermen reported a 400 percent catch increase (appendix E2f and figure 63), largely targeting grounds beyond Chile's 200-mile limit (appendix E2b and figure 14). The current focus on fresh product, however, limits the range of fleet operations, although the fishermen on freezer vessels can freeze the fish taken the first few days to extend trip length.

A. Gear and equipment

Chilean fishermen use three types of gear to harvest swordfish. Data on the modern fishery is available beginning in the late 1930s. The small-scale artisanal fishermen catching swordfish at that time were using harpoons in small, open boats. Harpoons continued to be the primary gear employed until the mid-1980s. The use of harpoons limited the development of a significant commercial fishery because labor intensive harpooning was not particularly profitable to the fishermen, given the considerable effort required and the low prices available on the domestic market. (See "Catch.") Artisanal fishermen in the mid-1980s began shifting to more efficient drift gillnets.[458] Commercial fishermen subsequently introduced even more efficient longlines. Driftnets and longlines were introduced in the 1980s and through 1995 accounted for almost all of the Chilean catch. The fishermen in 1996, however, mostly used longlines. The characteristics of the gear are summarized in appendix D1a (figure 82). The new modern gears and fishing methods substantially increased the efficiency and productivity of the fishermen, enabling them to massively increase catches. (See "Species: Stock status" and "Catch".)

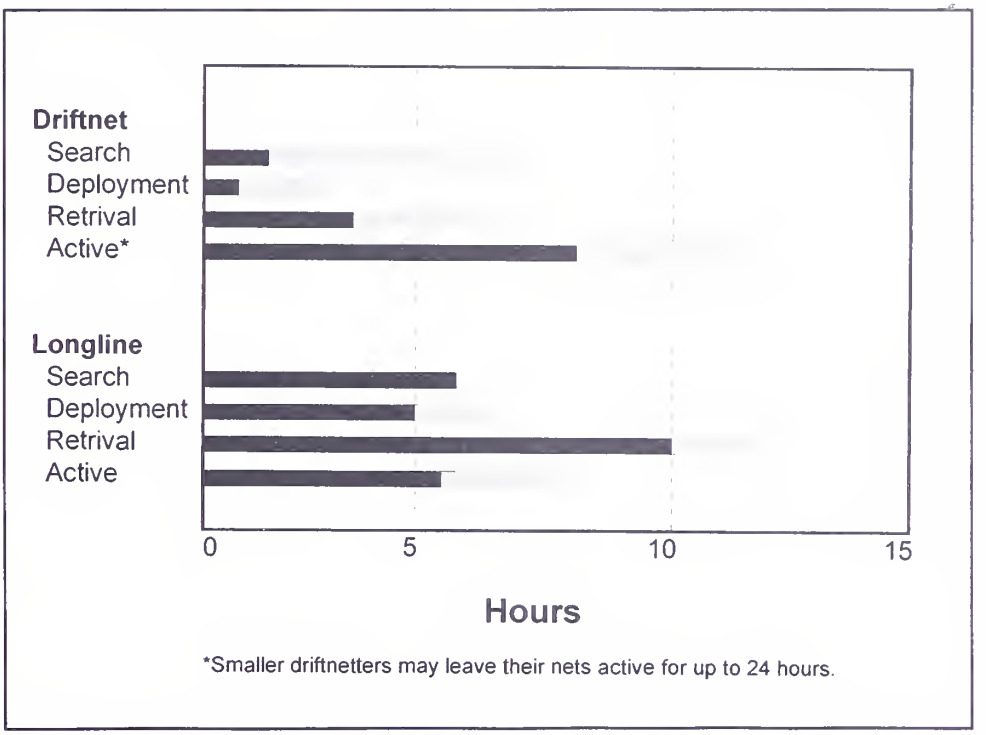

Figure 82.--Driftnets take less time to deploy than longlines, but both gear are left active for about the same time.

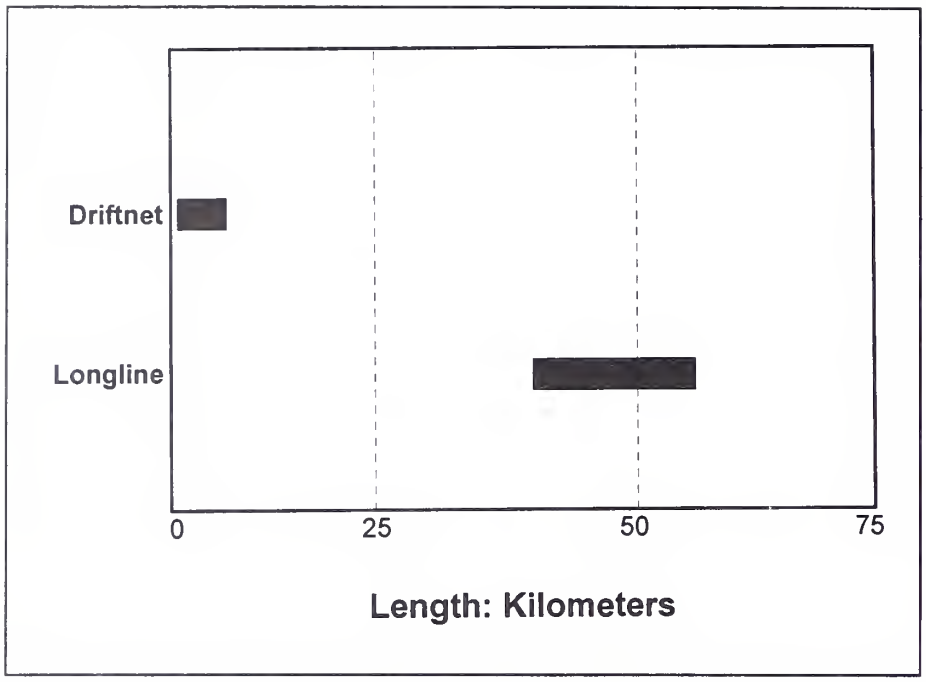

Figure 83.--Chile's artisanal driftnets are only a fraction the length of commercial driftnets.

Chilean vessels, both the longliners and many of the artisanal driftnet vessels, are equipped with a variety of electronic instruments. The instrumentation includes echosounders, radios, radar, temperature detectors, and FAX machines to receive SST readings.[459] Many are now beginning to add computers so they can take advantage of data services offering more current SST readings.[460] (See "Remote sensing" below.)

1. Harpoons ("Arpones")

Harpoon gear consists of a metal (usually bronze) point ("flecha"), a wood or steel shaft approximately 2 m long, a connecting line to the float ("reinal"), another line ("cable"), and a float ("flotador"). A platform ("tangón") bolted to the bow of the boat helps the fishermen spot the dorsal fin of the fish as well as providing a stable throwing platform (photos 54, 55, and 57).[461] The harpoons are hand held and thrown. FAO experts attempted to introduce harpoon "rifles" in the 1950s. At least one company had experimented with them. The rifles were generally considered dangerous by the fishermen and rejected.[462] The point of the harpoon is designed so that once it penetrates into the flesh of the fish it holds firm and the fish can not escape. The harpoon shaft is attached to a steel cable (50-60 cm in length and 0.4 cm in diameter) joined to a line of approximately 20 meters. A rope of 500 m is attached to the line.[463]

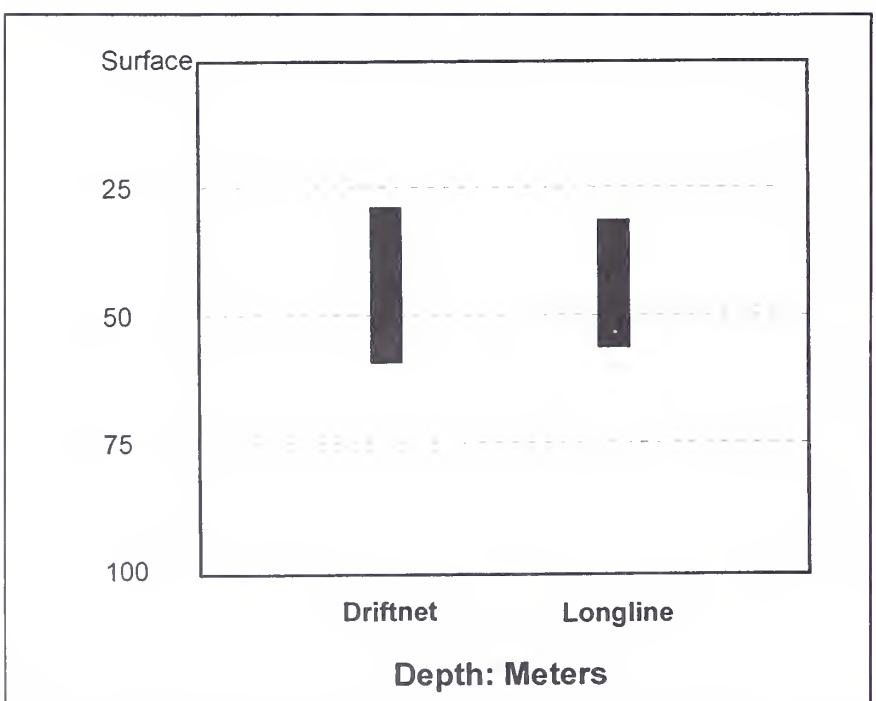

Figure 84.--Driftnets and longlines are set at about the same depth.

2. Driftnets ("Redes de enmalle/pared")

The characteristics of the artisanal and commercial driftnets commonly used in Chile are as follows (appendices D1a ad D1b1 and figure 82):
Dimensions: The artisanal driftnets vary from about 0.7-1.5 km long with nets of about 1.1 km long and 30 m deep the most common.[464] Another observer reports somewhat larger artisanal nets of up to 1.8 kilometers with vertical drops of about 45 meters. The commercial driftnets are larger, averaging about 2.4 km with vertical drops of up to 60 meters (photo 61).[465] One report suggested that the commercial driftnets were

reportedly as long as 4.3 kilometers (appendix D1b and figure 83).[466] SERNAP officials report, however, that driftnets are limited to 2.47 km without exception.[467]

Panels: The driftnets are composed of separate panels which when joined extend up to 2.4 kilometers. They can be separated to make handling the net easier. An artisanal net of 1 km, for example could consist of 10 panels, each about 0.1 km long (photo 62).

Mesh: Artisanal and commercial fishermen commonly use similar mesh of about 51-56 cm (20-22 inches), diagonally stretched measure ("entrenudo") (photo 63).[468]

Deployment: The net size is commonly suspended about 30 m below the surface, but can vary from 30-60 meters (appendix D1b and figure 84).[469] A lead line on the bottom holds the net down. Floats and buoys are attached horizontally about every 46 meters (photo 64).

Photo 61.--Even the artisanal driftnets require a substantial effort to haul and deploy.

Regulations: Net size is limited by SERNAP which place limitations on length and area. The SERNAP regulations vary, depending on the size of the vessel. (See: "Government Agencies and Policy".)

Photo 62.--Most of the artisanal fisherman haul their nets by hand. Dennis Weidner.

Photo 63 --Driftnet fishermen use a large mesh for swordfish and then then a smaller mesh or lines for demersal species during the rest of the year. Dennis Weidner.

Configuration: While SERNAP regulations limit length and area, the fishermen are allowed to have various configurations, a 24-25 square km net, for example, could be 800 by 30 m or 1,000 by 25 meters.[470]

Material: The monofilament nets are most commonly made of polypropylene. A common diameter for the filament is about 2.0-2.5 millimeters (mm).[471] The rigging coefficient is 0.5.[472]

Light sticks: Most Chilean artisanal fishermen use light sticks ("luces químicas") with their driftnets. The fishermen have adopted the sticks from the longline fishermen who introduced them. Each captain has his own preference on how to use them, and are thus set at varying depths on the net.[473]

3. Longlines ("Espineles" or "Palangres")

Chileans primarily use Spanish-style longlines. A few fishermen have in recent years begun to experiment with American-style longlines. The characteristics of the longlines commonly used are (appendices D1a and D1b1 and figures 82 and 84A):

Material: The longlines were originally made of a polyethylene twine, but most fishermen are now using monofilament nylon main line (photo 65).[474] The hook branches are polyethylene or monofilament as well as galvanized wires. The Spanish-style longlines are monofilament motherlines, polypropylene vertical hook lines ("reinales"), and galvanized wire leader for the hooks. The American-style gear has polypropylene rather than the wire leaders for the hooks.[475]

Length: The commercial fishermen employ Spanish-style long lines. The authors have received somewhat varying estimates concerning the lengths of longlines employed by the commercial fleet. SERNAP reports artisanal main lines ("linea madre") of about 3.0-4.5 kilometers.[476] SSP reports lines of up to 16 kilometers.[477] One industry source reports several longlines of about 40-50 km (photo 66).[478] Another industry source reports that longlines average about 55 km in length.[479] Available data suggests a range of 40-55 m (appendix D1b and figure 83). Some of the artisanal fishermen also deploy small longlines (photo 67).

Depth: Most Chilean longline fishermen report setting their hooks at depths of about 33-55 meters (appendix D1b and figure 84).[480] The small number of fishermen experimenting with American-methods report setting their hooks in deeper water up to about 90 meters.[481]

Hooks: Chilean artisanal and commercial longliners are capable of deploying anywhere from 600-2,500 hooks per set.[482] Observers vary somewhat, however, on the number of hooks commonly deployed. One source estimates that commercial longliners often use 1,200-1,600 hooks per set.[483] Another source indicates the fishermen generally employ about 2,000 hooks on each set.[484] The smaller artisanal longlines average about 1,000 hooks.[485]

Light sticks: All Chilean longline fishermen use light sticks extensively. Most fishermen commonly attach them to each vertical hook line, close to the bait. It appears that the light helps to attract bait fish and the aggregation of prey items attracts the large predators rather than direct attraction to the light. The Chilean fishermen are still experimenting with placement, lightstick decay, color, and other factors.[486]

Regulations: There are no regulations limiting length (photo 66). The SSP has, however, issued regulations which limit the number of hooks. The SSP regulations vary, depending on the size of the vessel. (See: "Government Agencies and Policy".)

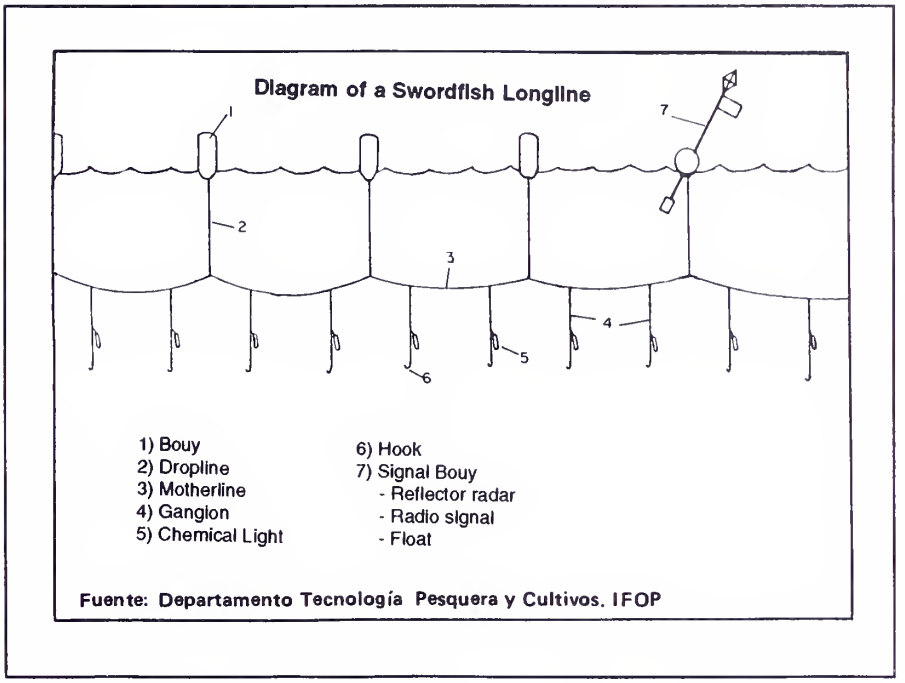

Figure 84A.--Diagram of Chilean longline. IFOP

Photo 64.--Flag markers with floats are placed in the water to indicate the location of the driftnet sets. Dennis Weidner

***Photo 65.**--A fisherman preparing the line for one of Chile's modern longliners at the port of Coquimbo. Dennis Weidner.*

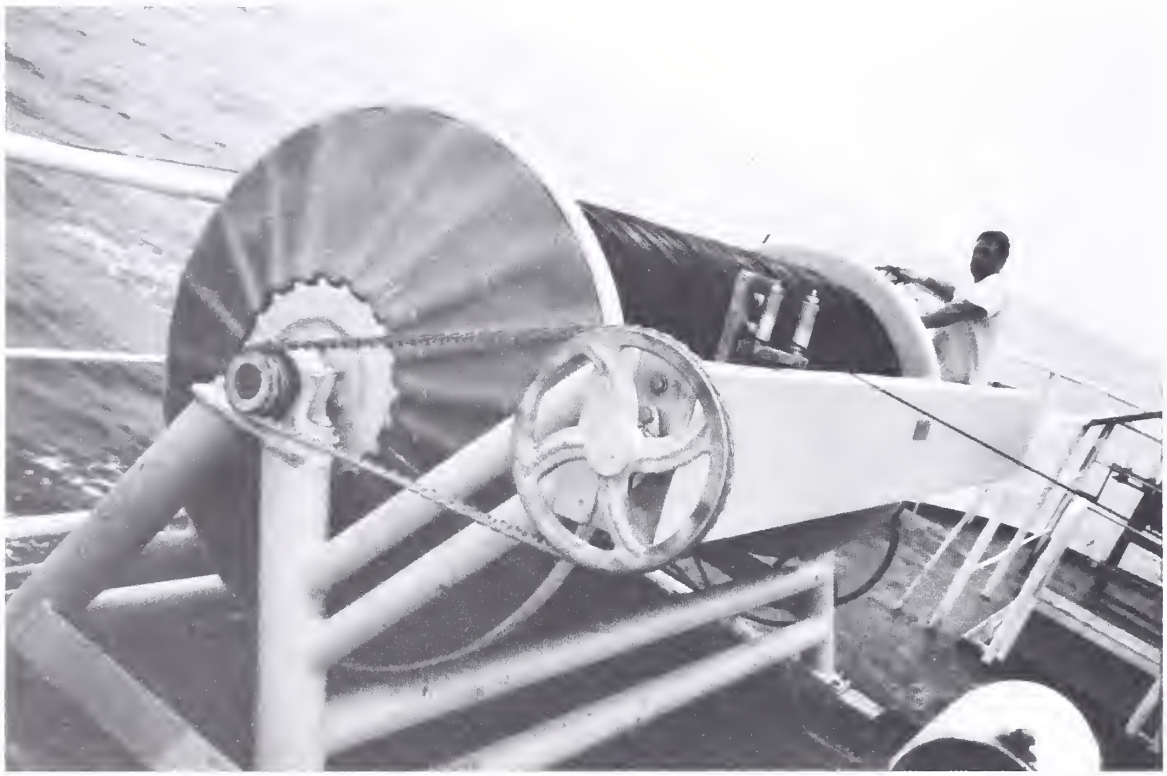

Photo 66.--Chile has several large modern longliners, deploying motherlines of 40-50 kilometers. Dennis Weidner.

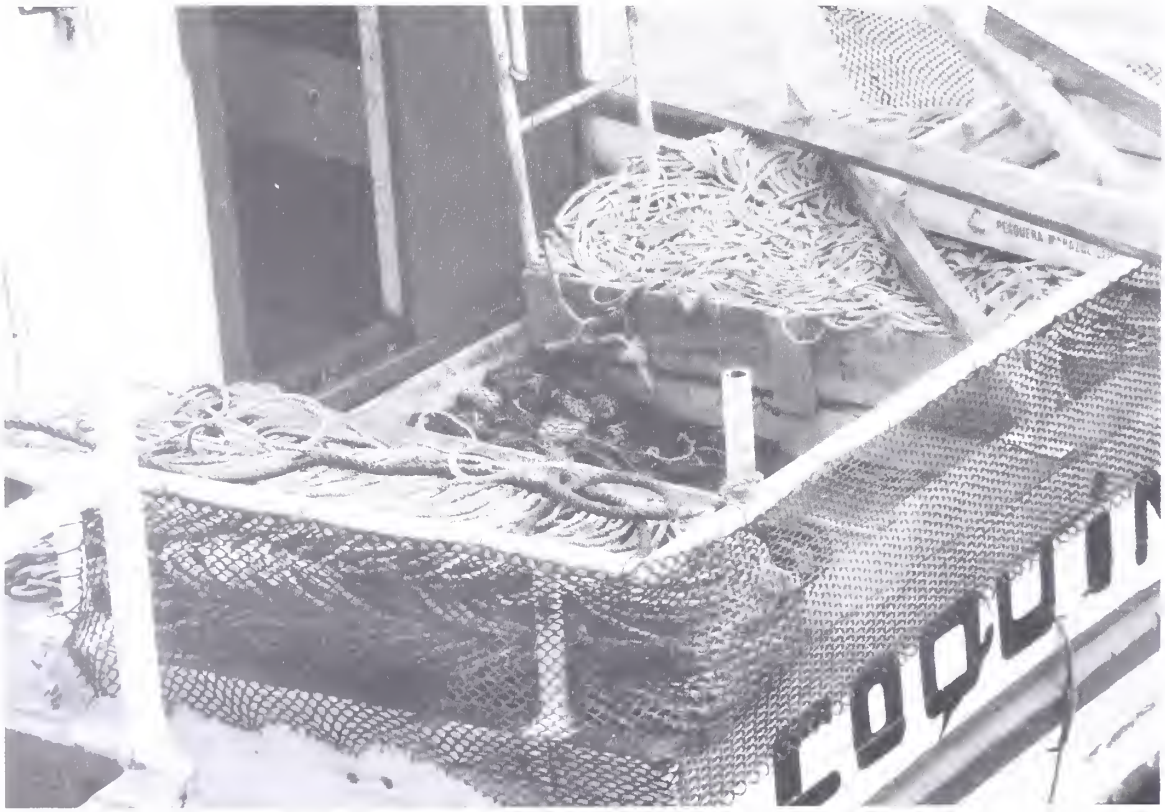

Photo 67.--A few artisanal fishermen also deploy longlines, although much smaller than those deployed by the commercial fishermen. Dennis Weidner.

B. Fleet operations

Operations of the artisanal and commercial fleets vary substantially because of the variety of vessels and gear and different grounds fished. Most of the artisanal fishermen have shifted from harpoons to driftnets. The commercial fishermen entering the fishery turned primarily to longlines. Both artisanal and commercial operations since 1991-92 have been affected by the declining catch and the need for both artisanal and commercial fishermen to shift further and further from the coast--significantly extending trip lengths. Fleet operations are largely governed by the conflicting need to operate an increasing distances from the coast to find the fish and the contrasting need to limit the duration of trips so that the fish landed will be high-quality fresh product. (The characteristics of Chilean fleet operations are summarized in appendix D1a and figure 82.)

1. Artisanal fleet

Artisanal fishermen have to register with SERNAP as required by the Ley de Pesca y Acuicultura. SERNAP maintains the Registro Nacional de Pescadores Artisanales. The artisanal fishermen are defined principally by the size of the vessel which is limited to 18 m or 50 GRT. They fishermen are allowed to own up to two vessels. They can operate in various fisheries as long as they are conducted within the same region, although there are some exceptions--primarily for migratory species.[487] The exceptions are particularly important for the swordfish fishermen as the species is highly migratory.

a. Harpooners

The harpoon ("arpón") fishery peaked during the 1940s and has since declined. (See "Catch.") The artisanal fishermen use harpoons during the mild and relatively calm Summer and early Fall at the beginning of the year (January-May) when the fish can sometimes be found at the surface during the day. Fish can only be harpooned during calm weather as this is when individual fish can be found basking.[488] Also this approach is most successful close to the coast, especially in green water ("agua verde"). Further from the coast in blue water ("agua azul") it was much more difficult to approach the fish and the harpooners who could reach the more offshore areas had to move with some speed.[489] The fish are reportedly vulnerable to harpoon fishing because after extended foraging dives into deep cold water, some apparently need to warm up which they can most quickly accomplish by basking in the sun at the surface. This may explain why the fish are most commonly seen basking during the warm early months of the year (Summer and early Fall) because the surface water is warmest at this time. After May, the fish are less prevalent in surface waters and are thus not commonly available to the harpooners.

Northern fishery: The harpoon fishery conducted off the northern coast during the 1930s-50s was an arduous, often dangerous undertaking. Swordfish was the only species targeted by the harpooners. A U.S. observer in the 1950s described artisanal operations out of Pisagua, a small port north of Iquique. The most common boats were open bongos 5-6 m long, usually powered by small, often unreliable 5 hp motors. Some fishermen still used sails.[490] The crews were 2-3 men who mostly worked coastal waters (photo 68). Most of the strikes were 10-50 km from the coast.[491] Some fishermen fished much further off the coat, but accounts vary. U.S. recreational fishermen active in Chile during the 1950s reported artisanal fishing up to 160 km off the coast and as far as 240 km north or south from their

Photo 68.--Three men crews harpooned swordfish on the open sea from small boats landing substantial catches until the mid 1960s.

Photo 69.--Harpoon fishing is increasingly rare, but a few artisanal fishermen still make occasional trips during the peak season. Dennis Weidner.

home ports.[492] An FAO expert reports operations even farther off the coast, out to 290 kilometers.[493] The fishermen sometimes lingered several days at sea, totally exposed to the elements in their open boats. Oars were often used when approaching the fish. Throwing platforms ("tangones") were not used during the 1950s, but later adopted by some fishermen (photo 69). The fishermen threw the harpoons, often with great accuracy, in a long high arc. After striking the fish, a terrific battle ensued, the fishermen clinging to the line with bare or gloved hands. If the harpoon did not strike vital organs, a fish harpooned at dusk could continue fighting well after sunset. Fishermen rarely reported taking a swordfish in less than 3 hours during which an exhausting, often dangerous struggle ensued with the fish. The small boats were often dragged for kilometers. After finally boating the fish, it was stowed under burlap bags which helped to cool it. The fishermen would literally sleep on top of their catch if the trip extended for a night or two. Some fishermen tied a barrel to the line and then retrieved the fish after it had tired swimming against the buoyant barrow. In some areas, this fishery was pursued by pairs of fishermen using sailboats deployed by "mother ships." In some instances fishermen were left at sea on four-log balsa rafts to tend caught fish so the catcher boats could continue working (Peru, photo 19). From a distance, the rising and falling in the water, gave the illusion of walking on the water. The local people referred to them as "men in Jesus shoes." For this enormous effort, the fishermen are often only able to sell their catch at very low prices--generating only bare subsistence income. Even so, prices for swordfish were higher than for other species. So many of the artisanal fishermen generally aspired to fish for swordfish.[494]

Central fishery: Some limited harpooning continued through the 1980s, mostly off the central coast which was never fished during the peak of the harpoon fishery in the 1940s. Some authors believe that swordfish were probably present off central Chile before the 1980s, but simply not accessible to the Chilean fishermen in their small boats.[495] Harpoon fishing has now almost completely been replaced by driftnetting, with two minor exceptions. First, some driftnet fishermen still use harpoons opportunistically. Second, a few small-scale fishermen, now mostly along the central coast, occasionally harpoon swordfish--although their small, open boats ("bongos" and "faluchos") are primarily deployed in other fisheries. (See "Fleet.") Most of the harpooning still occurs during the first half of the year (photo 69). The quantities now taken by the harpoon fishermen are a small part of the overall Chilean swordfish catch, but a successful strike can be quite profitable to these low-income fishermen. The apparent scarcity of swordfish in waters close to the coast has further limited the ability of these fishermen to continue participating in the fishery. The fishermen are simply unable to reach the increasingly distant fishing grounds in their small boats. (See "Fishing Grounds.") The fishermen which now may only work on a part-time basis, usually for more abundant species, leave in the morning and come back the same day (photo 69). Operations in the small open boats are limited to good weather conditions.[496] The authors have been unable to find a good account of directed harpoon fishing during the 1980s. Many sources indicate that such activities are now minimal.[497]

b. Driftnetters

Driftnets have been the most common gear used by Chilean fishermen for catching swordfish. Driftnets were introduced to artisanal fishermen through experimental studies and test fishing during the mid-1980s. (See "Research.") The driftnets

Photo 70.--Artisanal driftnet vessels are deployed for swordfish, usually from March to July/August, and then shift to demersal species. Dennis Weidner.

proved much more efficient than harpoons. As a result, for the first time the fish could be targeted at night while they were feeding. (See "Species: Feeding behavior.") The greater efficiency of the driftnets resulted in their rapid adoption by the fishermen. Artisanal fishermen began using monofilament driftnets during 1984-85 and due to the excellent results there was a massive shift to this gear in 1987-88 (photo 70).[498]

Seasonality: The artisanal fishery is highly seasonal. (See: "Species: Seasonality.") A few artisanal fishermen normally begin annual operations during January off Talcahuano and Valdivia (37°-40°S) in Region VIII (figure 2). The fishermen mostly fish out of Region VIII ports (Lebu and San Vicente) in the early part of the season (January to May). Artisanal catches during the first few months, however, are very limited (appendix E3a1 and figure 64). Most artisanal and commercial fishermen wait until March or even May to begin fishing (appendices E3a1 and E4a1 and figures 20 and 97). Fishermen during the early or latter part of the season are partially compensated for low catches by higher prices which prevail during the off season. The fishermen with the larger vessels shift to the best grounds along the coast as the season progresses. Port activity is highly seasonal, but available data may not reflect the actual seasonality of the surrounding waters (appendices A2c2 and E2d1 and figure 85). The fishermen operating small vessels (less than 12 m) can not follow migrating swordfish along the coast or go far out to sea and thus have to limit their activities to when the fish appear in the area close to their home port.[499] The artisanal fishery, primarily driftnet, is more seasonal than the commercial, mostly longline, fishery (appendices E3a1 and E4a1 and figures 20 and 97-98). (See "Species: Seasonality" for a fuller discussion.) While many fishermen withdrawal their vessels from the fishery after July and August, fishing from the northerly ports such as Coquimbo can increase as the fishery is winding down to the south (appendix A2d1 and figure 86).

Length of season: Driftnets enabled the fishermen to extend the season beyond the brief 3-month harpoon season which usually ended by May. The driftnet fishermen at the peak of the fishery in 1991 were able to fish for a much longer period, through July/August or September.[500] Some fished as long as 9 months, although many were active only 4-5 months during the peak months. The longer season combined with the greater efficiency of the nets has enabled the fishermen to land substantially larger quantities than the harpooners. The drastic decline of catches beginning in 1991, however, may eventually result in a shortening of the driftnet season. Catches during the end of the season (August and September) in 1993 and 1994 were quite small, but for unexplained reasons increased during the same 2 months in 1994 and 1995. Catches during the 1996 season fell sharply after June/July, except for a slight increase during October (appendix E3a1 ad figure 20).

Fishing grounds: The artisanal fishermen initially operated relatively close to shore, but in recent years have had to increasingly move further and further out to sea. Artisanal operations in 1996 were primarily conducted from 130-200 km offshore, which would mean on the outer fringe of the coastal zone.[501] For details see "Fishing Grounds". Many of the artisanal vessels are equipped with electronic equipment for navigation as well as temperature gages (photo 71). Some also have echo sounders.

Fishing operations: The driftnet is commonly deployed at dusk, often about 6:00 pm or at least by 9:00 pm. It generally takes 1-3 hours to deploy.[502] Fishermen in recent years have begun to add disposable chemical lights spacedat varying distances (35-50 m) to attract prey species which in turn attract the swordfish. The fishermen stay with the net

Photo 71.--Artisanal fishermen have electronic gear for navigation as well as equipment to help locate the best grounds to deploy their nets. Dennis Weidner.

during the night. The net is physically attached to the boat throughout the night, partly because it serves as an anchor and partly to avoid losing it.

Depth: The net is supported by buoys spaced about every 45 m and suspended 9-55/60 m below the surface. The depth of the set is largely determined by the lighting conditions which is affected by the lunar phase and cloud cover.[503] As the nets itself can be up to 60 m, the bottom of the net can reach to about 120 m deep.

Soak time: The soak time (period the gear is left active in the water) is normally 8-12 hours. This can vary somewhat as vessels with particularly small nets (less than 16 m) may leave their nets active in the water for up to 24 hours (appendix D1a and figure 82).[504]

Haul: The fishermen haul the net in at dawn or about 6:00 am after the evening set.[505] Hauling in ("virando") the nets is a labor intensive operation and can take most of the morning to retrieve the net when done by hand, depending on the catch and sea conditions (photo 72).[506] The fishermen have gradually begun to upgrade their gear and some have installed power blocks.[507] As the net is being retrieved, the fish are untangled and usually one person starts eviscerating the catch and storing it in the ice holds.

Handling the catch: After retrieving the fish, it is processed as trunks ("troncos") aboard the vessels. Depending on the captain, the fish may or may not be eviscerated immediately after being disentangled from the net. Some captains retrieve all of the fish first and then begin eviscerating. In the early afternoon after finishing the haul, the captain proceeds to search for signs of swordfish (such as oil slicks from defecation) or the water color for indications on where to make the next set.[508] The eviscerating process involves cutting off the heads, tails, and primary dorsal fin. The trunks are then stored on ice.[509]

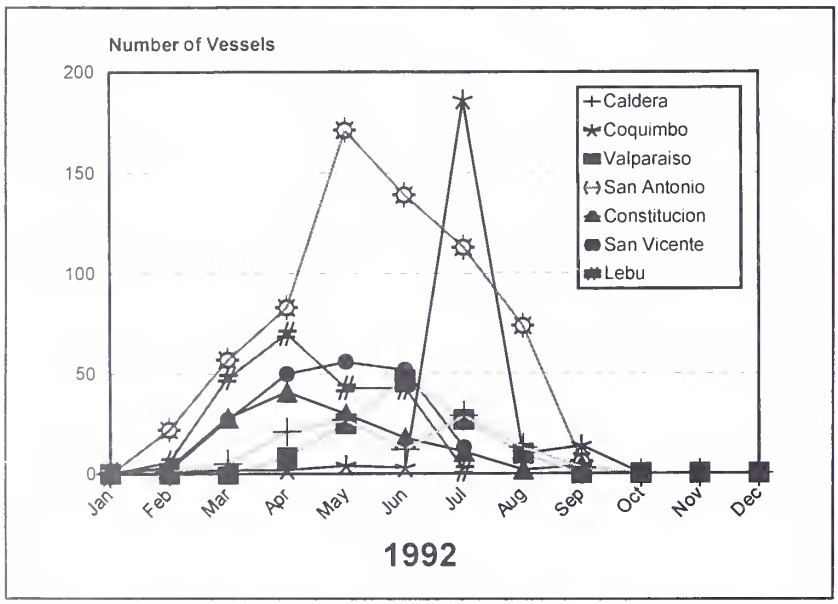

Figure 85.--The number of swordfish vessels operating out of Chilean ports can vary substantially from month to month.

Trip duration: Chilean artisanal fishermen normally report fishing trips of from 3-12 days. Even the larger artisanal vessels are restricted to trips of no more than 15 days as they only have ice holds to maintain the catch (photo 73). Initially trips were commonly about 3 days as the fishermen operated very close to the coast.[510] Another report indicated that trips

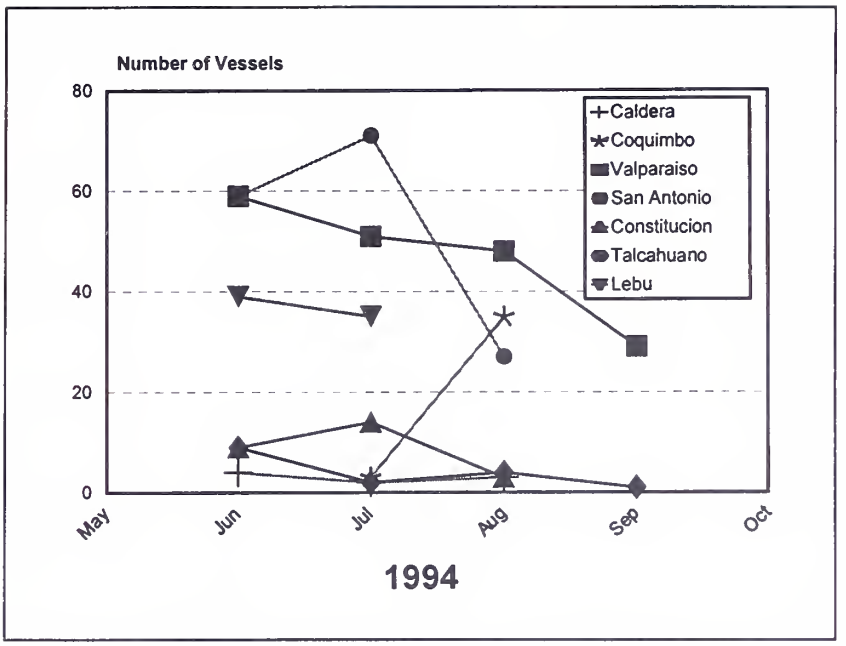

Figure 86.--The number of vessels operating out of central ports declined after July, but increased in Coquimbo.

continued for only about 3 days as recently as 1989 (appendix D2b2).[511] The fishermen in 1991 were reporting longer trips averaging about 5 days (appendix F1).[512] As the fishery developed, trips were increasingly longer, averaging 4-7 days (appendices D2b2 and F1).[513] A recent report describing 1994-95 operations suggested fishermen are making longer trips, currently averaging about 8 days, in part because of the need to reach grounds located further off the coast.[514] The duration continues to increase and artisanal fishermen in 1996 were commonly reporting trips of 10 days.[515] Many artisanal fishermen now report operating 80-250 km off the coast, which would mean areas outside the 120-mile (192-km) reserved zone (appendix D1). The smaller artisanal vessels make especially short trips. Trip lengths are affected by a variety of factors, including the vessel size, distance from the fishing grounds, weather, fishing results, and other factors. The artisanal fishermen operating from different ports report relatively similar operations, but there are some minor differences. Vessels based in San Antonio report somewhat shorter trips while those based in Lebu and Constitución reported longer trips (appendix F1). As the fishermen continue to extend trip duration, the need for improved handling measures is becoming more important. One industry source reports that fishermen are studying the feasibility of installing small ice making machines (500 kg per day).[516] Details are not yet available for 1996, but the increasing trip duration is believed to be one factor affecting profitability and the sharply lower 1996 artisanal results (appendix E2f).

Photo 72.--Many artisanal vessels still have manual equipment to retrieve lines and nets. Dennis Weidner.

Number of trips: Artisanal fishermen in 1989 were reporting about two trips per month (appendix D2a).[517] A more recent report suggests that the fishermen continue to make at least two trips per month during the peak season.[518]

Sets: The number of sets per trip vary from about four to eight (appendix D1a).[519] The number of sets can vary significantly, depending primarily on the duration of the trip which is affected by the factors described above. Most of the vessels will try to set once a day, although the small vessels with little driftnets may leave their nets in the water longer, thereby reducing

Photo 73.--Artisanal driftnet fishermen have been making longer trips to grounds further offshore, adversely affecting their profitability. Dennis Weidner.

the number of sets possible during each trip (appendix D1a and figure 82). The number of sets for all of the vessels will be less than the number of days for each trip as it usually takes 1-2 days to get to the fishing grounds.

Opportunistic harpooning: Artisanal fishermen rely primarily on driftnets, although they may often also use harpoons opportunistically if they happen to spot a basking swordfish during the day (photo 74). The fishermen during the early months of the season (January through May) use both harpoons and driftnets, the harpoon in the morning and the driftnets at night. As the weather deteriorates after May, fewer swordfish are spotted at the surface and the fishermen rely almost entirely on their driftnets (May through August).[520] A few fish are also taken by artisanal fishermen who do not conduct directed swordfish operations, but take swordfish opportunistically as part of line or driftnet operations for other species.[521]

Alternative fisheries: The artisanal vessels are multi-purpose vessels. Almost all of the fishermen pursue other fisheries after the swordfish season. Many engage in bottom longlining for demersal species along the southcentral coast. The declining swordfish yields since 1991 has caused many artisanal driftnetters to shift to demersal species in recent years even during the swordfish season (photo 75). (See: "Species: Yields.") This shift was particularly notable in 1996 (appendix E2f). Price fluctuations also affect the species that the fishermen choose to target.

Crew: Crews on the average artisanal driftnet vessel are made up of about six-seven individuals, including the captain (usually the owner), mechanic, cook, and three or four crew members (appendix D2c and figure 87). Other observers report eight-person crews are more common. The arrangements are usually informal

Photo 74.--Many artisanal vessels primarily used driftnets, but have "tangones" for opportunistic harpooning. Dennis Weidner.

***Photo 75.**--Many artisanal fishermen shift fisheries on a seasonal basis. These fishermen deploy small mesh nets after the swordfish season.*

***Photo 76.**--The crews vary considerably because of the wide range of vessels employed in the fishery, 6-7 persons, are the most common. Dennis Weidner.*

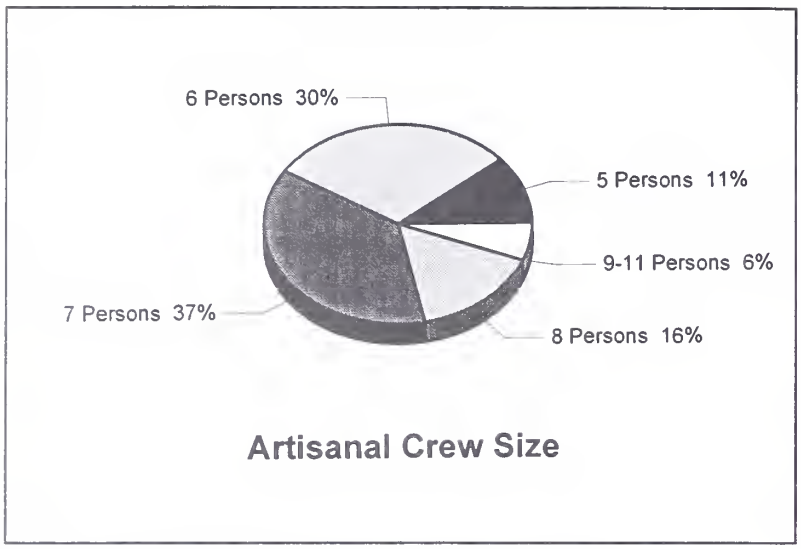

Figure 87.--Most of the artisanal vessels have crews of 6-7 persons.

(photos 70,75, and 76). Crew members usually do not agree to any long-term arrangements, but decide from week to week whether to work and for whom.[522] The crew's earnings are based on a share of the catch. Often the vessel owner will get half of the proceeds with the remainder split among the crew in a proportion varying as to the individual's position and the ownership of the net.

Ownership: Ownership of the vessels varies widely between regions (photo 77). Only a few of the small vessel operators in the important San Antonio/Valparaíso area (Region V) own their vessels, but many more in the Talcahuano area (area VII) (appendix A4c and figure 88). Ownership of the fishing gear also varies. The vessel owner may own his own gear or may use gear provide by the crew (photo 78). There are informal associations ("confianza") of deck hands on trust which have purchased a driftnet. Some processing companies also furnish gear to the vessel owner.[523] Only limited data is available on gear ownership (appendix A4c).

Artisanal fishermen are reporting increasingly disappointing swordfish yields with driftnets. The poor 1996 season has reportedly convinced many fishermen that there is no future in driftnetting swordfish. Some fishermen are currently studying the yields obtained through longlining. A small number of the artisanal fishermen are already longlining. One industry source believes that there may be a gradual shift by the artisanal fishermen to longlining.[524]

2. Commercial fleet

The commercial fleet is also defined primarily by vessel size, vessels over 18-m long. Most of the commercial catch is taken by longlines. Several companies, noting the success artisanal fishermen reported with driftnets and lucrative export sales, decided to enter the swordfish fishery during the late 1980s. Most eventually turned to longlines. IFOP and other Chilean groups had compiled a body of information on longline fishing. The Chilean Government contracted for longline studies as early as the 1950s.[525] Chilean researchers began testing commercial longline gear during the 1970s.[526] (See "Research".)

Chilean companies began to assess the possible deployment of longliners in 1986 drawing from research data compiled by IFOP and other research groups. Companies introduced the first commercial longliners to the swordfish fishery in 1989. The longliners acquired were generally much larger than the artisanal driftnet vessels. (See "Fleet.") This permitted extended voyages to offshore grounds. The

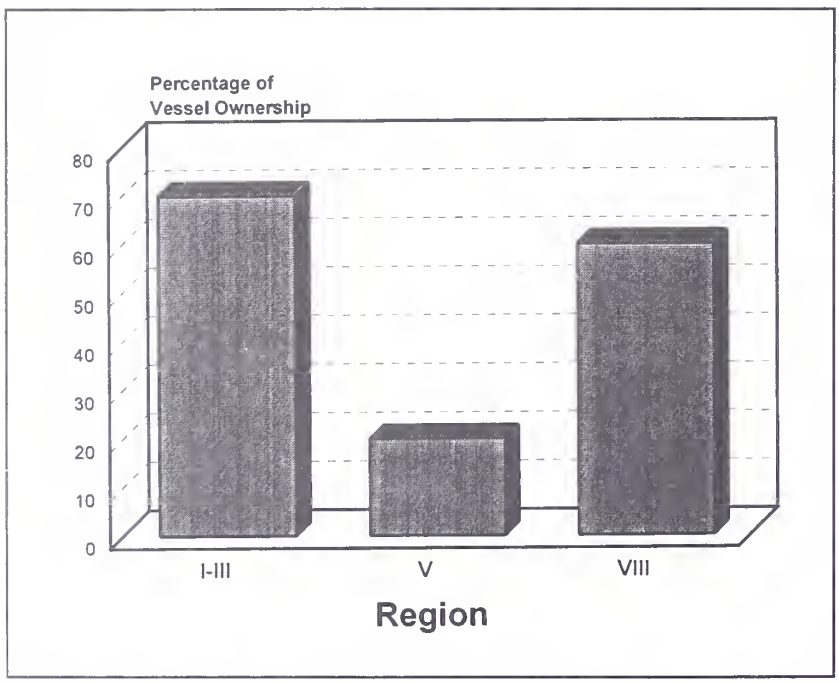

Figure 88.--Ownership of the artisanal boats varies significantly by region.

Photo 77.--Many of the vessel operators do not own the vessels, but this varies from port to port. Dennis Weidner.

Photo 78.-- Some crew members have formed associations to purchase driftnets and work as a group aboard the artisanal vessels. Dennis Weidner.

longliners were mostly equipped with freezers so the catch could be preserved, thus permitting lengthy voyages to offshore grounds and the capability to remain there for extended periods. The declining prices for frozen product since 1993 (appendix G4a and figure 94), however, have caused the commercial fishermen to withdraw many vessels. The remaining companies now focus almost exclusively on fresh fish. (See "Processing and Products.") Commercial fishermen are reporting trips at considerable distances from the coast--some as far as 1,300 km offshore--to maintain catch levels. (See "Fishing Grounds.") The current focus on fresh product, however, places limits on the autonomy of the vessel and range of fleet operations. Chilean companies now deploy relatively few longliners, but the vessels are some of the larger Chilean vessels and they account for an important part of the catch.

The commercial fishermen, primarily using longliners, have in some years (1991-92) accounted for over half the Chilean swordfish catch (appendix E2f). The number of vessels, however, has been limited. Even at the peak of the fishery in 1991-92, a relatively small number of longliners were deployed. One source suggests 15 commercial longliners, but the numbers may have been some what larger. SERNAP reports that 22 commercial longliners were active from San Antonio and northern ports during 1993, but not all of these were deployed for swordfish. Only about 5 commercial longliners reportedly operated out San Antonio (Regions V) in 1996.[527] Some of the generally small Constitución longliners (Region VII), were also deployed for swordfish (appendix A3d and figure 74). A few artisanal longliners were also active.[528]

Basic information on longline operations is as follows:

Companies: Seven companies are known to have operated swordfish longliners during 1994-96, including: Pesquera Apóstol Santiago, Pesquera Calcurrupe, Empresa del Estrecho, Pesquera Montemar, Pesquera Omega, Pesquera Santa Lucía, and SOPESCA-ALIMAR (appendices A3b and e). In part because of the declining catch, several of these companies (Pesquera Montemar and Pesquera Santa Lucia) as of 1996 had withdrawn from the fishery. (Details on several of these companies are available in "Organizations: Companies.")

Grounds: The commercial vessels operate from Valparaíso north to the Peruvian border, as far as 1,300 km out to sea but not close to the coast because of the 120-mile (192- km) coastal zone reserved for the artisanal vessels.[529] Longline fishermen fish from about 200-1,300 km off the coast. An average trip during the early 1990s was about 500 km (photo 79). Few artisanal longliners ventured beyond this distance. Given the shift to grounds beyond the 200-mile limit in 1996 (appendix E2b), it is likely that average trip lengths have increased. The Spanish fishermen who operate off Chile tend to fish further south and west than the Chileans, although there are seasonal operations along the 200-mile limit.[530] (For details see "Fishing Grounds.")

Seasonality: The commercial fishery, primarily longline, is less seasonal than the artisanal driftnet fishery (appendices E3a1 and E4a1). Commercial catches are reported throughout the year, especially the larger commercial vessels operating beyond the 200-mile limit. (See "Species: Seasonality".)

Number of trips: Especially during the peak season there is a strong motivation to return immediately to the fishing grounds after landing their catch. Active longliners currently average about 9-10 trips annually.[531]

Trip duration: The duration of longline trips is affected by the size of the vessel, weather conditions,

Photo 79.--The large commercial longliners can operate farther off the coast and endure rough sea conditions. Dennis Weidner.

distance to fishing grounds, fishing results, and other factors. One of the principal factors is the type of operations conducted. Operations landing frozen fish do not require short trips. The commercial vessels equipped with freezer holds are mostly longliners and are capable of extended trips. The large size of the longliners as well as their freezers give them the capability of conducting trips of 2 months or even longer. As a result, the longliners made much longer trips than the driftnet vessels, preserving the catch by freezing it. There was no need to return immediately to port after only a few days of fishing to ensure the quality of highly perishable fresh fish. Long trips of 2 months or more, however, were unusual--even when the vessels were landing frozen product.[532] One company reported trips of 30-40 days.[533] Average longline trip lengths, however, have declined sharply in recent years and are now relatively short because most of the vessels are operating as fresh fish vessels. Even after shifting to fresh fish, some of the commercial longliners report somewhat longer trips than the artisanal fishermen. One reason for this is that they operate on more distant grounds requiring longer trips. The commercial vessels are required to fish outside of a 120-mile (192-km) coastal zone reserved for the artisanal vessels. In addition, many companies are deploying their longliners at increasing distances from the coast, in some cases extensively outside Chile's 200-mile zone (appendix E2b). This means that considerable time is devoted to getting to and returning from the fishing grounds. (See "Fishing Grounds.") The maximum range of vessels landing high-quality fresh fish is about 15 days, although some companies make even longer trips of 20-25 days.[534] Fishermen on such long trips would spend the first 2-3 days on route to the fishing grounds. They would then freeze the fish caught during the first few days because they would not be high-quality fresh product by the time they were landed. Some longline trips from Coquimbo in 1996 were as long as 22-25 days which can include 2 days to get to the fishing grounds and 2 days to return. Other longliners reported that generally trips were somewhat shorter, often only 15-18 days.[535] Another observer reported the vessels averaged trips of about 20 days.[536]

Fishing operations: The longline fishermen operate virtually 24 hours a day. Normally they begin setting the lines at about sunset. It takes any where from 5-7 hours to bait and set the line, depending on the length and fishing conditions (appendix D1). This means that the gear is usually fully deployed by about 12:00 midnight. The vertical lines to which the baited hooks are attached are spaced about every 55 m for swordfish (photo 80). The fishermen leave the line active in the water for about 6-8 hours. They then begin to retrieve the line a little after sunrise, anywhere from 6:00-8:00 am. The retrieval process can take 10-12 hours, depending on the catch and sea conditions. As a result, the fishermen can be ready to begin another set about sunset. Sets can be delayed by a variety of factors, including weather conditions, unsuccessful searches for the appropriate water temperatures and colors, accidents, and other factors. Most Chilean fishermen use Spanish longlining techniques, but a few small longliners have adopted American methods.[537]

Spanish: The fishermen use boxes of hooks, each box has enough hooks for 200 meters of line. Usually about 6 boxes of line are set extending 1.2 kilometers. Each set involves about 400 hooks. The authors have received a variety of estimates on hooks and have been unable to resolve those discrepancies. The fishermen can deploy up to 1,800-2,300 hooks per set. The vertical hook lines are generally spaced at 3.0-4.5 meters on the mainline. The hooks are set at depths of about 33-55 meters. Sets at these depths result in substantial shark by-catches. The fishermen use light

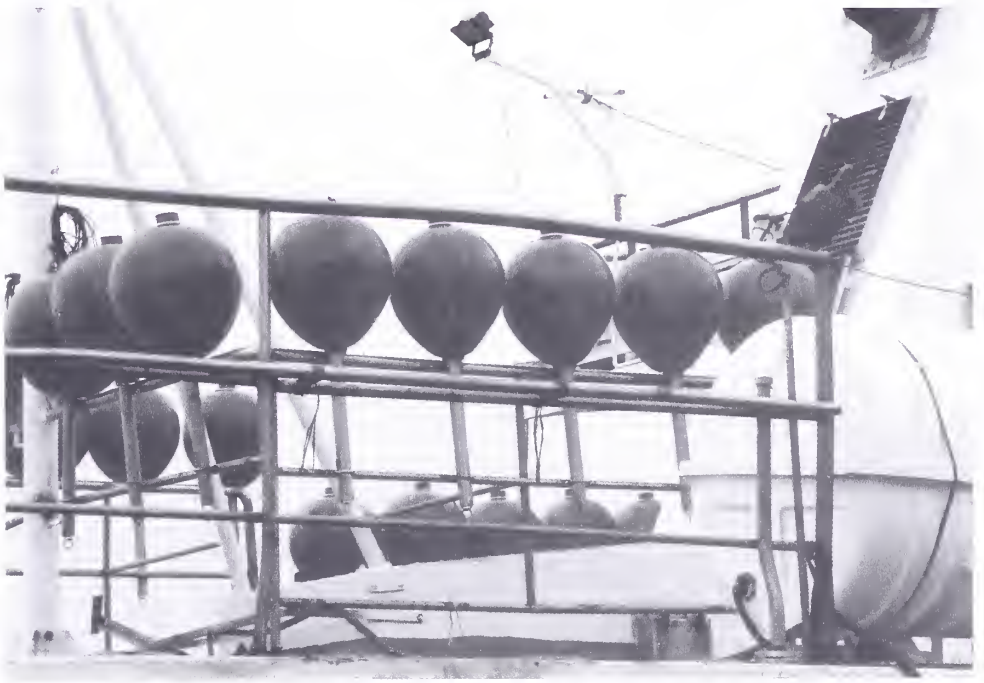

Photo 80.--Floats used to mark a longline set. Dennis Weidner.

sticks and generally horse mackerel ("caballa") as bait.[538] The Spanish-style longliners have two hydraulically operated metal plates set at the bow. The plates are spun to retrieving the longline.

American: The America style methods tend to deploy fewer hooks and generally set them deeper, up to about 90 meters.[539] The fishermen have lines of up to about 65 km, but generally only deploy 40-50 kilometers. They make extensive use of light sticks and normally use squid ("pota") as bait. The line is retrieved with a hydraulic reel where it is stored. The deeper sets means that there are generally smaller shark by-catches.[540]

Gear: The commercial fishermen use a variety of gear, but longlining is their principal method. One 1994 study indicated that the gears most commonly utilized by the commercial fishermen were currently: longlines (72 percent), driftnets (27 percent), and both gear (1 percent).[541] **Bait**: Chilean fishermen generally use horse mackerel (*Scomber spp.*) and squid (*Illex spp.*) for bait. A few fishermen also use jack mackerel (*Trachurus murphyi*).[542] The small number of fishermen using U.S. methods mostly use squid. Notably the fishermen do not generally use jack mackerel. This appears to match the feeding patterns of the fish. The fish along the coast targeted by driftnetters, which do not require bait, feed heavily on jack mackerel. Fishing in offshore waters targeted by longliners, which do use bait, feed heavily on squid and horse mackerel. (See "Species: Feeding".)

Sets: The number of sets is a function primarily of trip length. The fishermen aided with satellite imagery have become vary skilled at reducing time spent finding the productive grounds to a minimum. Longline fishermen try to make one set daily, although this is rarely possible. The number of sets is thus determined by the length of the trip minus the time it takes to get to the fishing grounds and days lost to adverse fishing conditions. The longest trips currently reported are about 25 days, with about 4 days devoted to reaching the fishing ground and returning to port. As a result, trips with up to 20 sets are possible. The fishermen would ideally like to make one set per day, but this rarely happens. The fishermen making an average trip of about 20 days would normally report about 11-15 sets per trip.[543] Shorter trips would reduce the number of sets by about one per day.

Handling the catch: After retrieving the fish, it is processed as trunks ("troncos") aboard the vessels (photo 81). The fish are eviscerated, the heads and tails cut off along with the primary dorsal fin.[544] Initially the longline fishermen froze the trunks, but in recent years, especially since 1993, the vessels have shifted to fresh product and, as a result, the longline fishermen are now also storing most of the trunks on ice.[545] The fish taken during the first few days of operations, however, may be frozen to ensure product quality.

Crews: Crews vary depending on the size of the vessel, but may include about 15-16 persons (captain, mechanic, cook, and 11-12 crew members).[546]

Photo 81.--This commercial longliner catch is headed and gutted and stored as fresh or frozen catch. Sebastian Vera.

Photo 82.--Artisanal and commercial fishermen are reporting increasingly small fish, like these fish landed by a commercial longliner at Coquimbo. Herman Caravajal Leon.

Alternative fisheries: The commercial longliners are purpose-built for longlining. As a result, it is difficult to rig the vessels for operations with other gear. Many of the companies, however, can use the vessels to longline for other species. Many of the longliners that were withdrawn from the swordfish fishery have been rigged for bottom longlining to target demersal species off the southern and southcentral coasts.

Home ports: The lager Chilean swordfish longliners have been mostly based in Coquimbo and Valparaíso. The catch is landed mostly at San Antonio and Coquimbo. Much of the longline effort in 1996 was conducted out of Coquimbo (photo 82).[547] There are, however, a number of smaller longliners deployed from Constitución, many of which target swordfish. (See: "Ports".)

Photo 83.--"Boating" a large swordfish is a difficult experience which few sport fishermen have achieved.

3. Recreational fleet

Recreational fishing is popular in Chile. The freshwater fishery for trout in southern Chile is world famous and has drawn the attention of many anglers in the United States and other countries. This fishery, however, is conducted in the lightly populated south and, as a result, enjoyed by only a small number of Chileans. Marine recreational fishing could be conducted along the much more heavily populated central coast and thus of greater recreational importance to the average Chilean. Despite the potential and extensive activity during the 1950s, the marine recreational fishery is currently very limited.[548] The country has not seriously developed its potential for marine recreational fishing. A variety of species are taken by anglers from piers and rocky outcroppings, but there are very few private boats used for recreational fishing and no commercial operations offering party boat trips for marine species. (See "Fleet.") There is, however, some activity. There are several active clubs, especially in the north. A few companies promote fishing in tourist areas. Facilities are available in several areas which could be used by recreational fishermen.[549]

Some recreational fishing for swordfish and other billfish was reported off Chile and Peru beginning in the 1930s. Reports of large swordfish being taken by artisanal fishermen reached American and European anglers. As early as 1934 anglers began setting records for swordfish in Chile.[550] Articles appeared in fishing and outdoors magazines (photo 83). The individuals involved received some support from the Grace company which at that time included the future Pan Am airline. The company saw fishing as an attraction that might draw tourists, increasing traffic on their ships and planes. Grace even helped ferry sport fishing boats to South America (photo 84). Some basic development of a marine recreational fishing industry began. A few hotels catered to the anglers. Some, such as the Hotel Pratt in Iquique, even had boats available for the fishermen. Artisanal harpoon fishermen worked as guides. One noted angler reported that the artisanal fishermen were "well trained as rod and reel guides and, like the Peruvians, are fearless when it comes

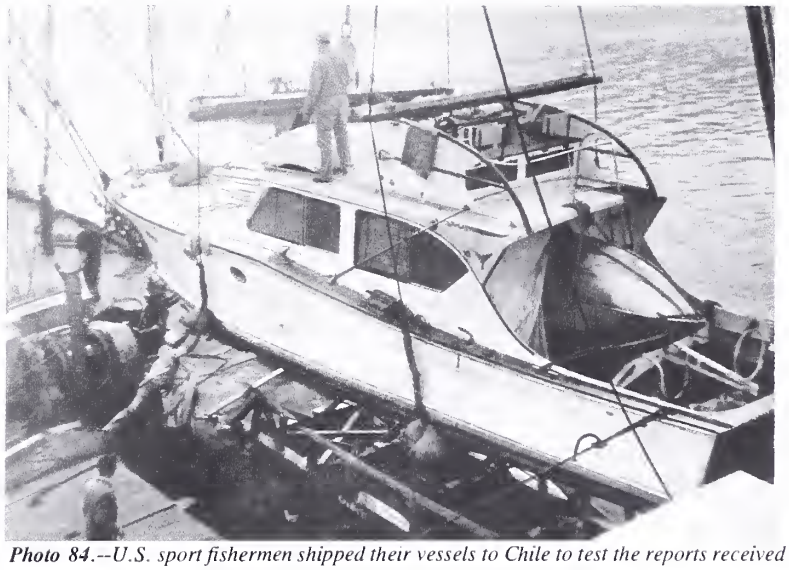

Photo 84.--U.S. sport fishermen shipped their vessels to Chile to test the reports received of giant swordfish.

to handling big fish and handling a boat as she should be handled."[551] Much of this effort ended, however, with World War II when available ships and planes were used in the war effort. Some fishing was later reported in the 1950s after the war. The Chilean Hotel association ("Consorcio Hotelero de Chile") was instrumental in reviving marine recreational fishing after the War. The results were impressive. One list compiled in March-June 1953 showed large numbers of swordfish (up to 536 kg, the world record) and stripped marlin (up to 200 kg) being landed in Chile (photo 85). It is unclear why commercial development did not follow. Noted American anglers visiting Chile spoke in glowing terms of both Chile and the big game fishing. Several sport fishing records were set in Chile, mostly for swordfish. These records were, however, being set primarily by foreign fishermen. Actual Chilean pursuit of recreation fishing has been very limited. A few Chileans took up the sport and several of the large fish taken in 1953 were taken by Chilean and Argentine anglers.[552] As recently as the 1980s, some foreign recreational fishing was reported in Chile.

Iquique: The all-tackle world record for swordfish caught on hook and line (536 kg) was taken off northern Chile, out of Iquique (Region I) during 1953.[553] This was the largest recorded swordfish ever caught on rod and reel.[554] Two other swordfish records (344 kg and 350 kg) were also reported during the early 1950s.[555] Catches of marlin and other billfish were also reported (photo 85).

Tocopilla: Some outdoor correspondents during the 1930s investigated reports of large swordfish being caught off Chile. Some experimental recreational fishing was reported out of this small port north of Antofagasta (Region II) during the mid-1930s and early 1940s. Even so, U.S. recreational fishermen reported taking large swordfish (180-360 kg) and observed "finning" marlin (presumably black marlin) in the same vicinity.[556]

Algarrobo: Some test recreational fishing was conducted during the late 1980s at this beach resort and marina about midway between San Antonio and Valparaíso (Region V) (photo 58). A U.S. fisherman in 1988 and 1989 set two hook and line world records (242 kg and 298 kg, respectively).[557]

The method used by the recreational fishermen during the 1930-50s was generally to troll with baited hooks. One author has provided detailed notes on how to present the bait. He noted that the smaller fish most actively pursued the bait.[558] The anglers generally didn't fish in deep waters because it required a long trip and extended waits between strikes were rather dull. In addition, it was not very pleasant rolling around at sea in a small, drifting boat. Off Chile and Peru, squid were reportedly likely to take the bait before the swordfish. Also rough seas and strong currents often made fishing impossible.[559] As the fish feed at night, fishing would also be most successful at night. Nighttime operations would, however, probably not appeal to many sport fishermen.

Observers only casually aware of sport fishing think primarily of marlin and sailfish as the most prized species. Marlin are the billfish which provide the spectacular aerial acrobatics often photographed. To many committed anglers, however, it is the swordfish that is "the prize of prizes." Hooking and catching a swordfish is an art, perhaps the most complex and intricate accomplishment in sport fishing.[560] As one noted sports fisherman wrote:

> No words of mine could ever do justice to the broadbill swordfish as the greatest sporting fish of them all. He certainly has more idiosyncrasies and greater guile than any other fish I have ever encountered and is by all odds the most difficult to hook and, next to the black marlin, the most difficult to find.[561]

Recreational fishing for swordfish, however, is a highly specialized activity and much less common than sport fishing targeting other billfish. As a result of swordfish behavior, a recreational fishery for this species would probably only appeal to individuals especially interested in the species and would be relatively expensive.[562]

Photo 85.--Recreational fishermen reported spectacular swordfish catches off northern Chile during the 1950s, but marlin and other billfish were also taken.

Chile appears to have the potential to develop a marine recreational fishery, but the infrastructure is currently limited.[563] Modest-cost fisheries could be developed for species like flatfish, hake, various mackerels and jacks, kingklip, and other species. It may also be possible to develop a big-game recreational fishery for large pelagics such as bonito, albacore and other tunas, and swordfish.[564] Given the country's important swordfish resource, a big game fishery for that species would appear to offer the greatest potential. Some observers, however, have expressed doubts about the weather, especially high winds during the fishing season.[565]

Chilean officials have expressed an interest in reviving a marine recreational fishery. CORFO and the Servicio Nacional de Turismo expressed interest during the 1980s and were reportedly trying to arrange a plan to make fishing boats available to interested anglers.[566] Tours for marine fishing off Chile were advertized in the United States as late as 1987.[567] SERNAP currently regulates the freshwater fishery and has noted the recreational and economic benefits.[568] SERNAP officials would like to develop the country's potential for marine recreational fishing. There are also some private groups interested in this opportunity, the Federación de Caza y Pesca de Chile and the Asociación de Caza-Pesca y Lanzamiento. SERNAP and these private groups helped host the 20th South American Marine Sportsfishing Championships during 1996 as well as the First International Seminar on Recreational Fishing. SERNAP has prepared an inventory of potential species and infrastructure.[569] NMFS is providing some technical assistance.[570]

C. Company role

Chilean companies both operate vessels and purchase the catch of independent artisanal fishermen. The longliners are mostly owned and operated by companies. Companies also own some driftnet vessels, but most of the driftnet vessels are operated by individual fishermen. There are two different types of relationships between the companies and the artisanal vessel owner/operators.

Informal association: The processing and exporting companies have formed informal associations with many of the artisanal fishermen. The company will supply the owner/operators of the artisanal vessels with provisions and fuel as well as arrange for transporting the catch from the port where it is landed. Some companies also furnish the gear. The transport has to be carefully coordinated for the fresh landings because it is important to have trucks waiting to pick up the fresh product when it is landed, assuring that the catch is delivered as quickly as possible to the Santiago airport. Different companies have reported relationships with 30-60 artisanal fishermen. Several companies work closely with the fishermen to promote handling practices that ensure product quality.[571] These associations are informal agreements, usually sealed with a simple hand shake rather than with formal contracts.

Intermediaries: Some fishermen sell their catch to intermediaries who then sell to the processing companies. The intermediaries do not provide financing or technical assistance to the fishermen.[572] Some of the processing companies export their output themselves, including swordfish. Other companies simply process the fish and rely on the services of specialized exporters. (See "Organizations: Companies.") In some cases the exporters purchase the fish directly from the fishermen or intermediaries. The trunks are exported directly, but these exporters

contract packing plants to process the fish for value-added orders.

D. Employment

The swordfish fishery at its 1991 peak provided substantial employment. About 4,500-7,000 individuals worked directly on the vessels. As many as 30,000 individuals were involved in the overall industry, including support services.[573] Employment has fallen in recent years as the fishery has declined significantly from its 1991 peak. (See "Catch.") Given that the catch has declined by more than half, it is likely that there has been a commensurate decline in employment.

E. Remote sensing

Chilean researchers have done some work with remote sensing. The first remote sensing research was reported in 1987. (See "Research.") As is the case for much of Chile's fisheries research effort, the primary focus is on providing practical assistance to actual fishermen, rather than conducting purely academic assessments.

Satellite images have been used by Chilean fishermen for several years. The first images were introduced to the artisanal fishermen targeting longfin tuna/albacore (*Thunnus alalunga*) and swordfish in 1986.[574] Commercial fishermen landing fish for Chile's massive fishmeal reduction industry subsequently also began using the satellite data (figure 90).[575] The Universidad Católica de Valparaíso (UCV) began distributing satellite images to swordfish fishermen in 1989 and then began selling the images in 1991. The UCV purchases imagery from Chile's Centro de Estudios Espaciales (CEE) which highlights the temperature isotherms (figure 89). The CEE operates a tracking station for foreign satellites and thus has the capability to download data. At least one private

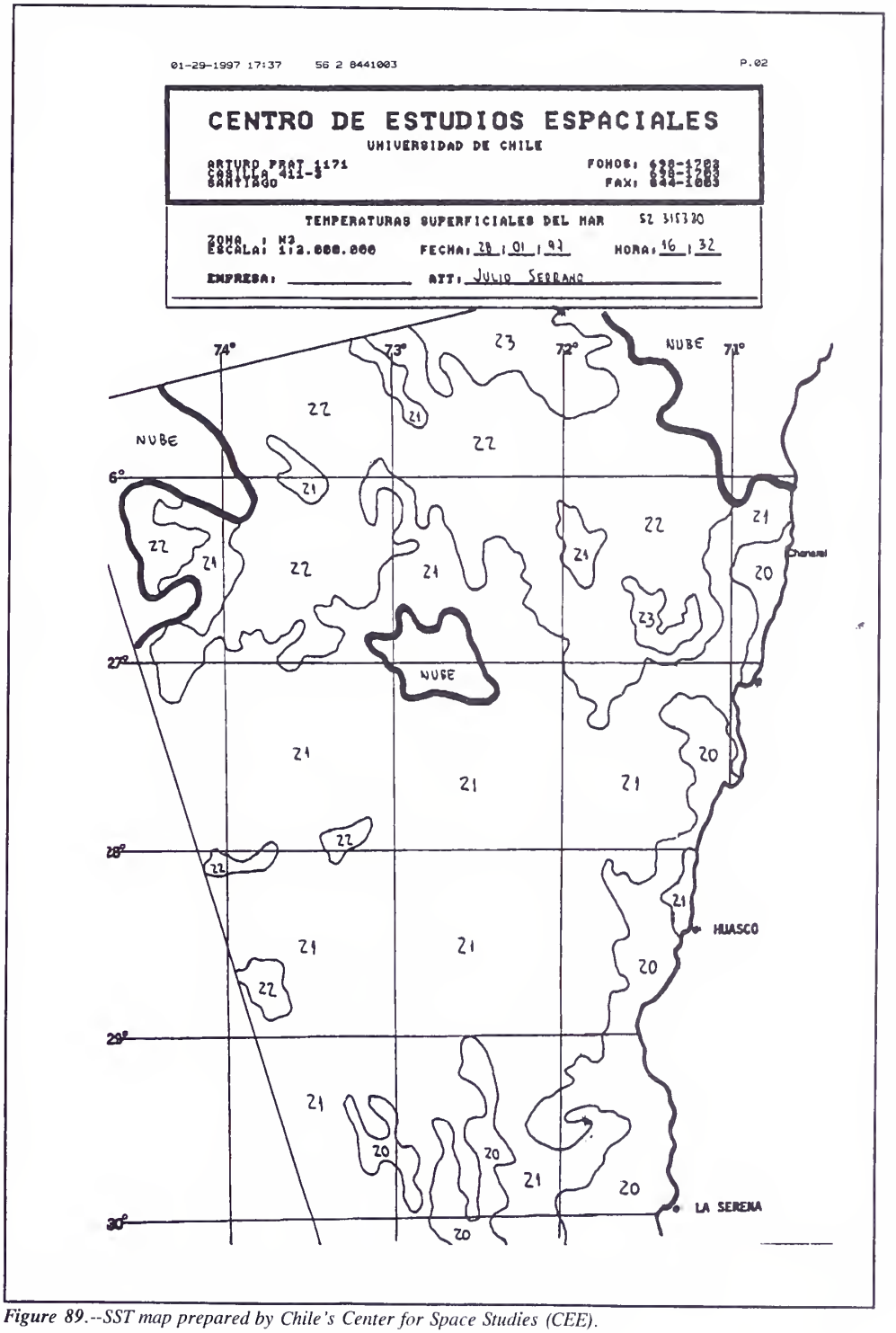

Figure 89.--SST map prepared by Chile's Center for Space Studies (CEE).

company, Kufax, is also involved.[576] (See: "Research.") The CEE uses data available from an AVHRR sensor on NOAA satellites (numbers 12 and 14) to obtain the sea surface temperature data. The UCV/IFOP uses the satellite images purchased from the CEE as a basis for producing imagery highlighting areas of possible abundance for fishermen targeting jack mackerel, swordfish, and other species (figure 90 and (90A). The UCV images are prepared by adding basic knowledge on swordfish behavior around temperature isotherms to the original CEE images. The Fishermen can obtain the UCV imagery with relatively inexpensive equipment, a simple modem and FAX. The images are currently purchased by most of the commercial fishermen and a substantial portion of the artisanal fishermen. Some artisanal fishermen order it directly. Some of the fish processing companies supply the data to associated fishermen.[577] The UCV currently reports selling the images to 30-40 percent of the artisanal fishermen. A much larger portion of the artisanal fishermen, however, have indirect access to the data. In addition, many of the artisanal fishermen make copies and disseminate them to their friends and colleagues.[578]

The satellite data is normally available daily. Chilean swordfish fishermen generally check the SST data about twice a week, depending on weather conditions. Wind has a significant impact on SST's and during periods of windy weather the fishermen may check more often than during periods of calmer weather.[579]

Both artisanal and commercial fishermen have found the satellite SST imagery useful in helping locate potential fishing grounds. The imagery greatly improves the surveying ability of the fleet.[580] (See "Fishing Grounds.") The satellite images provide real-time SST data over a wide area. The fishermen can then determine from the images the fishing areas most likely to be productive, significantly reducing wasted time at sea searching for the areas with optimal fishing conditions. Previously the fishermen had to expend considerable time and fuel searching for the right temperature conditions by using the temperature sensors on their boats--a very laborious process. The time and resulting expenses devoted to finding areas with optimal fishing conditions added greatly to operating costs. The SST satellite imagery

NOAA sea surface temperature and thermal gradient associated with swordfish fishery

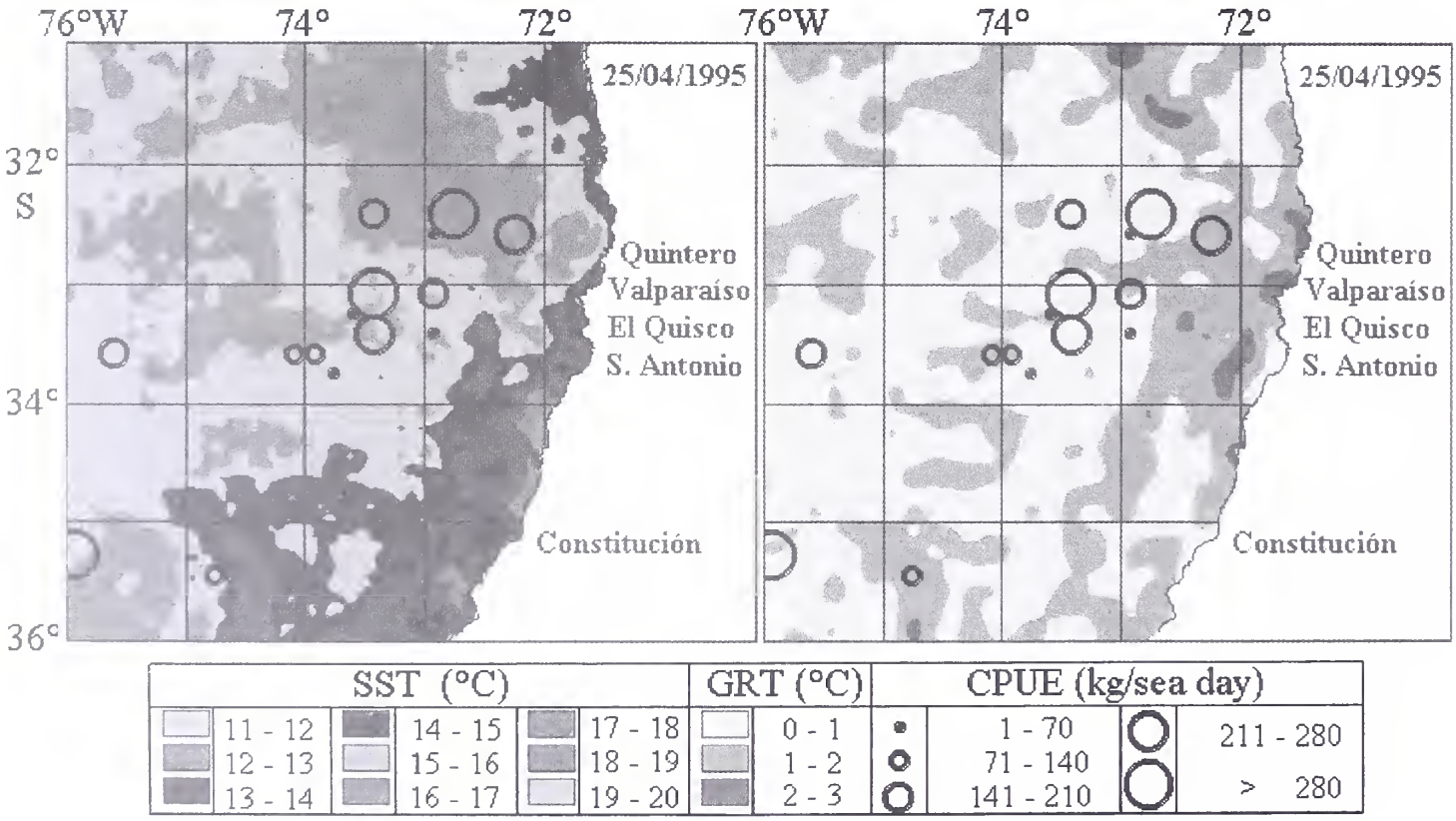

Figure 90A.--This is a sample of the UCV's printout on swordfish. The originals are in color.

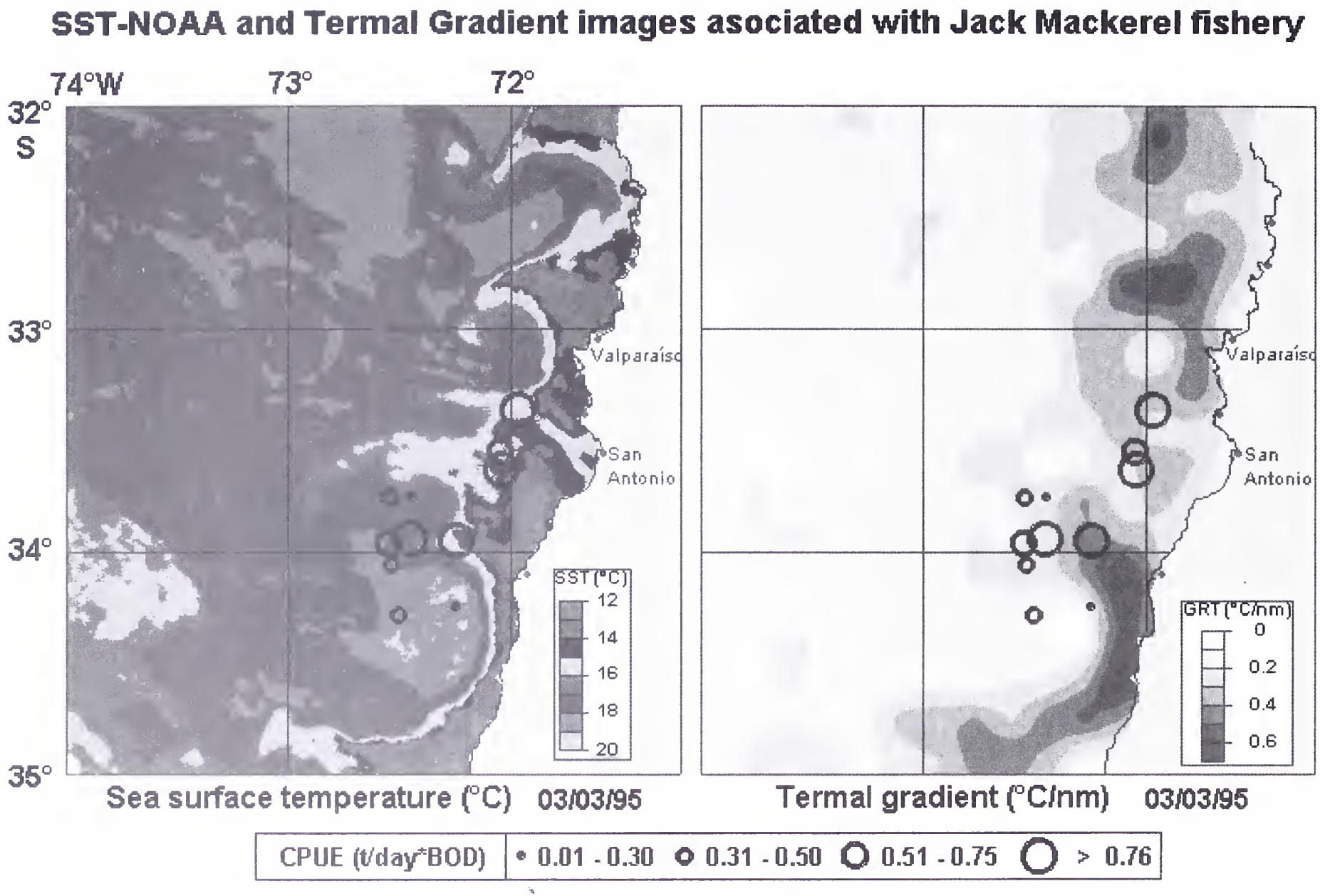

Figure 90.--The Catholic University of Valparaiso (UCV) uses the NOAA data processes by CEE to produce a variety of products like this map for jack mackerel fisheries.

has proven particularly valuable after periods of bad weather when the fishermen have had to come into port and have been off the fishing grounds.[581] The satellite SST images allow them to quickly locate grounds with the appropriate conditions--even if oceanographic conditions have shifted substantially while they were in port.

Chilean researchers have been actively assessing the satellite data. Several assessments have been published on swordfish and other species.[582] Researchers have identified varied species availability in the different temperature zones located by the satellite imagery. Swordfish are most abundant in the mid-range water temperatures.

Cold: The cold water in coastal areas (both upwelling areas and the Humboldt Current) is especially good for albacore tuna ("atún de aleta larga"). The albacore are reportedly found in areas of strong thermal gradients (2-5°C) which the Chileans refer to as "cantos".[583]

Mid-range: The mid-range temperatures, especially the mixing areas between the Humboldt Current and warmer oceanic water are best for swordfish. Thus the swordfish are generally found outside upwelling areas and the Humboldt Current, but within mixing areas with weak temperature gradients (about 1°C) where the water is often whitish.[584] (See "Species: Spotting techniques.") A recent study found the artisanal fishermen off central Chile reported their best swordfish catches in water with gradients of 0.2-1.2°C.[585] One company reports the best swordfish results in water of 16-19°C and uses the satellite data to find pockets of water where the temperature gradient is 1.0-1.5°C above that of the surrounding water.[586]

Warm: The warmer sub-tropical water appears to have higher concentrations of sharks.[587]

There are some limitations to the satellite data currently available. Cloud cover and fog can prevent the satellite from obtaining images.[588] This means that there are days when the images are not available or cover only limited areas. There are also occasional problems associated with correctly calibrating the sensor.

VII. Catch

Swordfish has been taken off Chile since pre-Colombian times. Chilean small-scale fishermen as recently as the 1940-50s took substantial quantities of swordfish with harpoons, but catches subsequently plummeted. The reasons for the decline of the artisanal fishery are not fully understood, but a combination of fishery-related, economic, social, and climatic factors appear to have been involved. The character of the fishery changed in the mid-1980s when more efficient gear was introduced and artisanal fishermen improved handling practices to produce a high-quality product for export. Both artisanal and commercial catches expanded rapidly to a peak of over 7,000 t in 1991, but have since declined significantly to only 2,600 t in 1995. The fishermen reported an increase to 3,100 t in 1996. The 1996 increase was primarily due to improved commercial catches on offshore grounds. The higher commercial catches more than offset lower artisanal due to the declining availability of the fish in coastal waters and the pursuit of alternative fisheries for more attractively priced species. It is unclear, however, if the 1996 results has reversed the long-term decline.

A. Historical background

Swordfish has been fished off Chile for centuries. Chilean archaeologists have reported evidence that native Indian populations took swordfish before the Spanish conquest. Swordfish bones are common in the cemeteries of indigenous populations in the Gulf of Arauco and in the coastal zone around Lebu (37°-39°S).[589] Despite this long history, the fishery was never developed as a viable commercial activity during the colonial period, but continued as a small-scale activity conducted mostly for subsistence or local sales at minimal prices.[590]

B. Modern era

Chilean fishermen conducted a substantial fishery for swordfish with harpoons. Little information exists on the origins of the harpoon fishery. A catch of over 2,000 t was reported in the mid-1940s. This fishery gradually declined during the 1950s and 1960s, reaching negligible levels by the late 1970s. The reasons for the fluctuations in the harpoon fishery are not fully understood as the authors have been able to find few published accounts of the fishery. Several factors could have affected the fishery, including overfishing, reduced effort because of alternative employment opportunities, impact on the ecosystem of anchovy fishing, climatic changes, or other factors. Some regional observers believe that El Niño events may have played a key role, especially in affecting the accessibility of the resource to coastal artisanal and recreational fishermen. Artisanal fishermen in the mid-1980s introduced highly efficient driftnets and the commercial fishermen during the late 1980s introduced longlines. These improvements resulted in dramatic increases in fishing effort. (See "Species: Effort.") As a result, catches rapidly expanded, reaching a peak of over 7,000 t in 1991. Catches subsequently dropped sharply. Yields had started to decline even before the 1991 peak, but expanding effort had enabled the fishermen to land increasing quantities of fish. (See "Species: Yields.") After 1991, the rapidly diminishing yields caused catches to decrease. A substantial number of fishermen withdrew from the fishery causing further catch declines. The swordfish catches steadily fell to less than 2,600 t in 1995. The causes of this decline have not been determined with any degree of certainty, in part because of the limited understanding of swordfish stock structure in the Pacific. (See "Species: Stock structure.") Many local observers are convinced that over-fishing is the primary cause of the decline, but a variety of other factors may have also contributed. (See "Species: Stock structure.")

1. Harpoon era (1800s-1985)

The authors have no information on the origins of the Chilean harpoon fishery. The existence of the fishery has been noted before the Twentieth Century, but few details are available. A few authors mention the fishery during the early part of the Twentieth Century. The earliest available data on the fishery dates from the late 1930s. The small-scale artisanal fishermen at the time were using harpoons and taking substantial quantities of swordfish. (See "Gear and Fleet Operations.") During a brief period in the 1940s, catches exceeded 1,000 tons during several years. The fishery peaked at 2,100 t in 1946. Information on the fishery is limited, but the fish was apparently sold as fresh product on the local market.[591] (See "Processing.") Reports of very large swordfish being landed in Chile attracted the attention of the recreational fishing community. Artisanal harpoon catches subsequently declined and by the late 1970s were negligible. The cause of the decline is unknown. Overfishing is one possibility. There are a variety of other possible factors, including the development of a huge small pelagic fishery for fishmeal reduction in the southeastern Pacific by Peru and Chile. Not only could the removal of massive

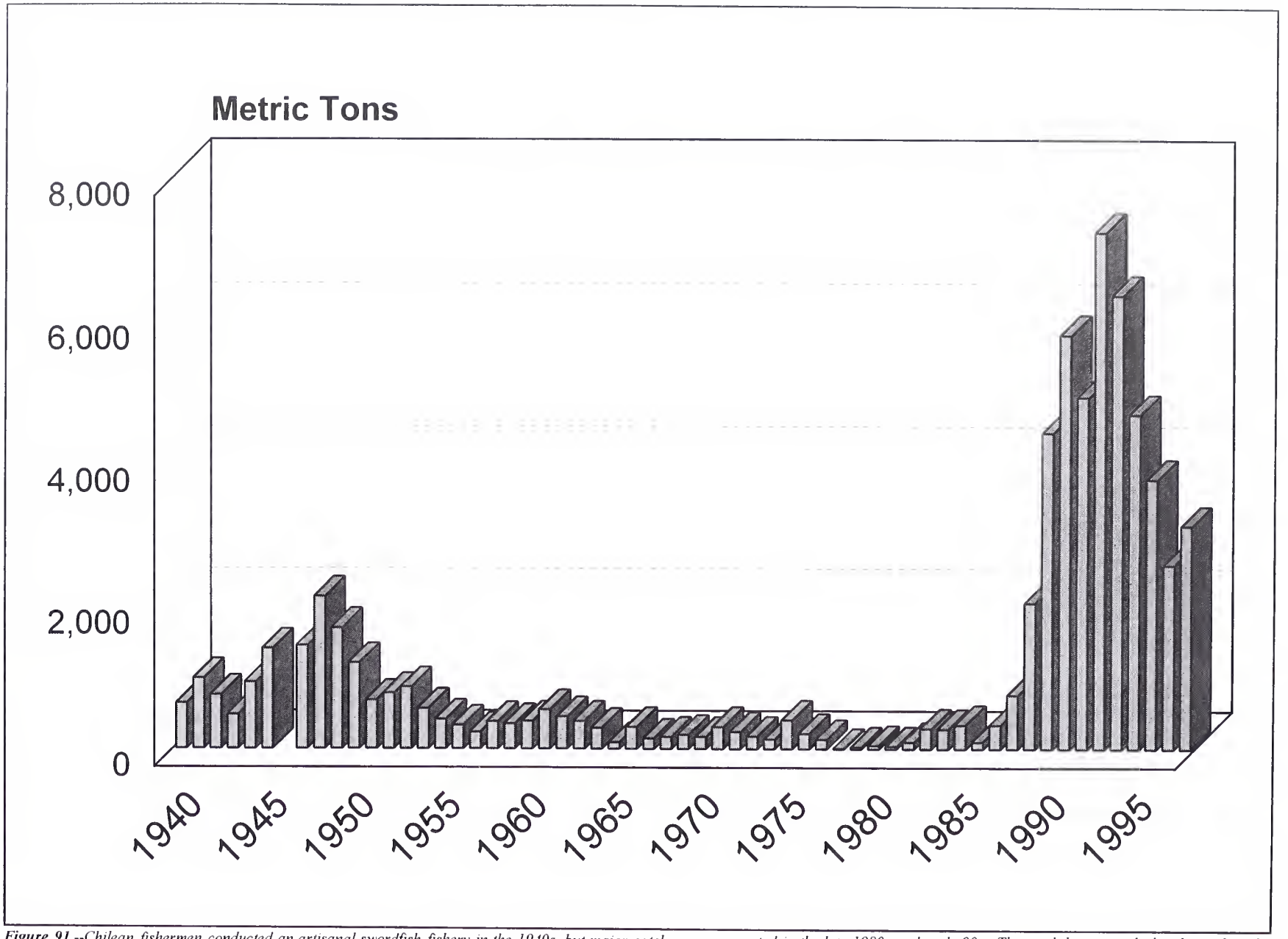

Figure 91.--Chilean fishermen conducted an artisanal swordfish fishery in the 1940s, but major catches were reported in the late 1980s and early 90s. The catch has since declined significantly.

stocks, but the job opportunities created by the new industry may have induced many small-scale fishermen to stop fishing. (See "Species: Stock status".) Some regional observers believe that climatic events, especially the periodic El Niño events, have had a major impact.

Annual fluctuations in the fishery were as follow:
1800s: The authors have been able to find no description of the fishery during the 18th Century, but Chilean authors have noted the existence of the fishery well before the 20th Century.[592]
Early 1900s: Little information is available on the origin of Chile's artisanal harpoon fishery. The fishery has been described in published reports as early as 1915 out of ports stretching from Arica south to Taltal.[593] Another observer mentions Arica to Huasco.[594] The fishermen during the early 1900s never ventured more than about 15 kilometers from port.[595]
1930s: The earliest catch data dates to the 1930s when somewhat fuller descriptions of the fishery become available (appendix E2a1 and figure 91). The Chilean fishery was conducted as an artisanal fishery with harpoons during the 1930s. Some limited historical information on the conduct of the fishery is available. (See "Gear and Fishing Operations".) The harpoon fishermen operated from small boats, almost exclusively off northern Chile--primarily landing in Arica and Iquique (photo 68). Most of the catch was sold fresh in the domestic market.[596] The first year for which catch data is available is 1938. Catch levels in earlier years are unknown. Chilean fishermen caught about 640 t in 1938 and increased the catch to nearly 1,000 t in 1939 (appendix E2a1 and figure 91). Given the limited yields from harpoon fishing, this quantity of fish must have involved a very substantial number of fishermen. Some recreational fishing for swordfish by anglers off northern Chile was reported in the mid 1930s. An Englishman working in Chile reported taking a world-record setting 380-kg swordfish.[597] (See: "Gear and Fleet Operations: Fleet operations.")
1940s: Fishing during the 1940s continued almost entirely off the northern coast. The catches declined in the early 1940s, falling to only 480 t in 1941. Catches increased sharply in 1942, however, and first exceeded 1,000 t in 1943. These are substantial quantities of swordfish, but the importance to the fishery is even more notable because at the time the entire Chilean fisheries catch was only about 35,000 tons. The Chilean harpoon fishery flourished during and immediately following World War II, exceeding 1,000 t annually (1943-48) and reaching 2,100 t in 1946 (appendix E2a1 and figure 91). It was about this time (1947-52) when the neighboring Peruvian fishery also expanded, eventually reaching nearly 7,000 t annually.[598] These very substantial quantities of swordfish were caught by harpooning, involving a massive artisanal effort. While most of the Chilean catch was marketed fresh domestically, some of the fish landed in Iquique was exported frozen to the United States. In addition, small amounts were canned in oil.[599] The Chilean fishery peaked at 2,150 t in 1946 but then began a long decline. The fishery fell below 1,000 t in 1949 (appendix E2a1 and figure 91). Shipments to the United States declined during this period. It is unclear why. It is possible that the end of World War II meant that the United States could refocus on economic activity and expanding domestic tuna and other fisheries more fully supplied domestic demand, reducing the need for imports. U.S. freezer tuna vessels were reportedly active off northern Chile, buying fish from the artisanal fishermen.[600]

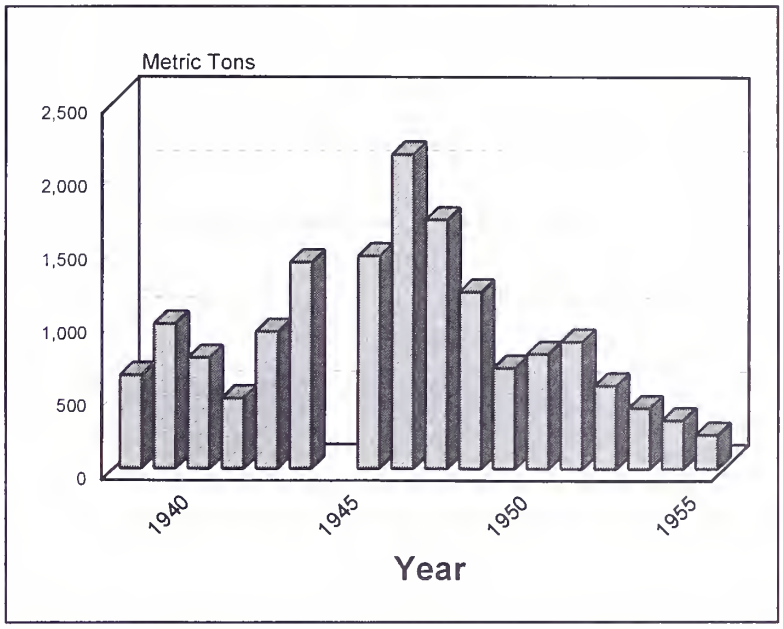

Figure 92.--The swordfish harpoon fishery peaked in the mid-1940s, but the reasons for the precipitous decline are not known.

1950s: The fishery, still conducted along the northern coast, improved slightly in 1950 and again approached the 1,000 t level in 1951. The fish continued to be consumed locally as fresh product (photo 86).[601] The decline resumed in 1952. One FAO report

Photo 86.--Virtually all of the substantial harpoon catch in the 1940s and early 50s was sold in the domestic market.

suggests declining abundance off the northern coast and a possible displacement to the central coast.[602] Catches fell in the northern ports with the exception of Antofagasta.[603] The 1955 catch fell to only about 240 t, but catches then improved slightly during the rest of the decade, reaching nearly 560 t in 1959 (appendix E2a1 and figure 91). It is unclear why the catches declined so precipitously during the 1950s. A variety of factors, some related to the fishery, such as overfishing may have been responsible. The quantities of swordfish taken by the small-scale harpoon fishermen in both Chile and Peru was substantial. Possibly resident coastal populations were fished out. Overfishing is, however, not a completely satisfactory explanation for the declining catches.[604] Another possibility is that both Chile and Peru began developing their huge fishmeal reduction industries in the 1950s. The removal of increasing quantities of fodder species from the ecosystem may have affected the populations of predator species like swordfish. Even if swordfish do not feed directly on these species, they may depend on them indirectly.[605] Thus small pelagic harvests could have affected the populations, or at least the availability, of swordfish in coastal waters where they were accessible to the harpoon fishermen and their small boats.[606] Other non-fishery related developments, such as economic and climatic shifts, could also have been involved. Job opportunities in Peruvian port cities increased as the canning industry began to grow in the late 1940s, followed by the fishmeal industry in the 1950s. Many low-income small-scale fishermen sought better paying jobs and less dangerous jobs as crew members or plant workers. Some observers believe that El Niño or other climatic events have affected swordfish abundance or at least vulnerability to the fishery, especially because the artisanal harpoon fishery were largely limited to coastal waters.[607] Peru and Chile were affected by an El Niño event in 1950-51 which may have contributed to the catch decline begun in the mid-1940s. These factors or a combination of them could explain the declining catches during the 1950s and 1960s, although such explanations are highly speculative. Some recreational fishing for swordfish was reported out of Iquique during the early 1950s. Sport fishermen following up on the pioneering work during the 1930s, caught the largest swordfish ever landed, a 536-kg giant in 1953.[608] (See: "Gear and Fleet Operations: Fleet operations.") The continued recreational landings of such large fish is one, albeit rough, indicator that the small-scale fishermen were not seriously depleting the resource. The first known scientific assessment of the large pelagic resource was done during 1955-56 by a U.S. researcher who reported that while the swordfish resource was concentrated off northern Chile, the species also occurred along the central coast.[609]

1960s: Chilean catches continued to decline steadily during the 1960s. The 1960 catch fell to less than 460 t and catches during the rest of the decade were even lower (appendix E2a1 and figure 91). The Fishermen generally reported catches of 300 t or less. The 1963 catch was less than 100 tons. One FAO report describes the small boat harpoon and tuna fisheries from Iquique and Antofagasta as being impacted by harvests of small pelagics to supply fishmeal plants and the demand of the local market for other species, but provides few details.[610] The fishery began declining in the north, partly because many of the artisanal fishermen who had been taking swordfish began moving to the Valparaíso area.[611] The fishery continued as primarily an artisanal harpoon fishery. Most of the catch also continued to be sold fresh in local markets.[612] It is unclear why the harpoon fishery declined during this period. The authors have no information on stock fluctuations or changing yields. It is likely that the development of other fisheries and, as a result, alternative job opportunities, both in the new fisheries as well as other economic sectors, may have the principal reason for the decline. Despite the artisanal nature of the fishery, costs were relatively high and results highly variable.[613]

1970s: Catches continued to decline during the 1970s. Most of the small catch was still landed at Antofagasta and other northern ports during the early 1970s. The highest catch during the decade was only

the 410 t taken in 1973 (appendix E2a1 and figure 91). The catch fell to minimal levels by the middle of the decade. The fishermen reported a catch of only 13 t in 1976 and the catch by 1979 was only slightly higher at 40 tons. The reasons for the decline are unclear, but a combination of fishery related and non-fishery factors were involved. Certainly the arduous process of harpooning swordfish from small boats was an important factor, but lack of yield data make any assessment difficult. A particularly powerful El Niño was reported in 1972-73 which could have been an important factor.

1980-85: Catches in the early 1980s increased slightly from the very low levels reported during the 1970s. Even so, catches during the early 1980s were still at extremely low levels, ranging from about 100 t (1980 and 1984) to 340 t (1983 and 1985) (appendix E2a1 and figure 91). The harpoon fishermen continued to market their catch locally at very low prices. These low prices simply did not motivate many fishermen to focus on the species because of the laborious process and limited yields involved with harpooning. Harpooning from small boats has since 1985 declined to minimal levels (photo 87). The dangers of harpooning swordfish from small boats was dramatically brought into focus in 1980 when 19 San Antonio fishermen were killed by unexpected bad weather.[614]

2. Driftnet and longline era (1986-to date)

Artisanal fishermen initiated the current swordfish fishery when they began using driftnets during the mid-1980s. They rapidly expanded fishing effort and developed lucrative export markets. The artisanal fishermen more than doubled catches from only 340 t in 1985 to 760 t in 1986 as the impact of the more efficient driftnets began to be felt. Commercial fishermen added to the growing effort by introducing longlining. The artisanal and commercial fishermen by 1991 had increased catches to a record 7,260 t (appendix E2a1 and figure 91). The commercial fishermen for a brief period in 1991-92 dominated the catch, but the artisanal fishermen regained their dominant role in the fishery by 1993 and have since retained it (appendix E2f and figure 64). The catch has since fallen continuously and precipitously from the 1991 peak. The 1995 catch was only 2,600 t, a decline of over 60 percent from 1991. The annual catch declines have been substantial, ranging from 12-46 percent (appendix E2a2 and figure 91). The steady declines were reversed in 1996 when fishermen reported a catch of over 3,100 t, an increase of 20 percent. The 1996 catch increase was due to a massive increase in the commercial longline fishery outside the 200-mile limit. The artisanal driftnet fishery in coastal waters declined substantially

***Photo 87**.--A few artisanal fishermen still harpoon swordfish, but it is only a part-time activity and the quantity landed is minimal. Dennis Weidner*

(appendix E2f and figure 64).

a. Annual fluctuations

Annual fluctuations in the fishery were as follows:

1982-85: Exporters began to experiment with small shipments of fresh swordfish to the United States in 1983 (appendix J3a1 and figure 140).[615] U.S. companies were anxious to identify additional supplies to meet the expanding demand for swordfish. The 1983 shipments were only 6.5 t and the apparent prices were relatively low (about $3.70 per kg) (appendix J3a1). Even at these prices, the export shipments proved profitable to Chileans because they were much higher than those available on the domestic market, attracting the attention of both fishermen and exporters. As Chilean fishermen improved their operations and product quality, they were soon able to command much higher prices (about $5.40 per kg in 1984), attracting even more attention. Before shipments could be significantly expanded, however, improved gear, new fishing methods, and larger vessels were needed to increase the productivity of the fishermen. The first experimental trials with driftnets were conducted by a private company, Pesquera Catalina in 1982.[616] (See: Research.") The Chilean Government in 1983 began to assist artisanal fishermen expand the fleet and acquire modern fishing gear through credits received from the Corporación de Fomento (CORFO)-Inter-American Development Bank (IDB) fisheries development project. The CORFO-IDB project channeled about $16 million into artisanal fisheries, much of which went for the purchase of vessels and equipment for the swordfish fishery.[617] The first reported deployment of a driftnet by an artisanal swordfish fishermen was noted in 1984.[618] The productivity of the nets was immediately apparent and several fishermen straightaway acquired the efficient new gear. Fishermen also began using light sticks.[619] Catches tripled in 1985 alone to 340 t (appendix E2a1 and figure 91). As a result, export shipments to the United States also increased from negligible levels to over 150 t or $0.8 million in 1985 (appendices J3a1-2 and figure 140). The Chilean catch during this period was entirely landed by artisanal fishermen.[620]

1986-87: The strong demand and alluring prices for swordfish on export markets, especially the United States, attracted the attention of an increasing number of fishermen as well as several companies (appendix G1d and figure 7).[621] This changed the character of the fishery in only a few years from a subsistence/local-market fishery with minimal quality standards to an export-oriented fishery requiring the

Photo 88 --Artisanal fishermen began using multi-purpose boats in the mid-1980s They reported catching swordfish during the fall-winter months, usually from March through June/July. D. Weidner

high quality standards needed to enter export markets. The growing number of artisanal fishermen began to explosively increase fishing pressure on swordfish.[622] (See "Species: Effort.") Artisanal fishermen rapidly made the transition from harpooning to driftnets.[623] The Chilean artisanal fleet is composed of multi-purpose vessels capable of targeting various species. (See "Vessels".) Beginning in 1986, many fishermen began deploying monofilament driftnets and turned exclusively to swordfish during the Fall/Winter season.[624] The small fleet of 25 vessels expanded explosively, although accounts vary substantially (photo 88). The SSP reports that the number of vessels registered to fish swordfish increased to 295 vessels in 1987 and 440 vessels in 1988 and a peak of 1,200 vessels in 1990-91 (appendices A2b and C1a and figure 73). These numbers, however, are somewhat misleading as a much smaller number of vessels, probably 600-700 vessels, actually conducted fishing operations.[625] The results were impressive. Catches increased to 765 t in 1986 and exceeded 2,000 t only a year later in 1987 (appendix E2a1 and figure 91). Chilean companies began to assess the possible deployment of longliners for swordfish in 1986, drawing on research compiled by IFOP since the 1970s.[626] Exports increased sharply. Shipments to the United States in 1987 totaled nearly 1,000 t (product weight) (appendix J3a1 and figure 140). Some problems developed as a result of high mercury content in the fish. The U.S. FDA seized 127 shipments of swordfish from 15 countries, including Chile, in the second half of 1987 because of high mercury content.[627] Some of the biggest shipments detained were from Chile.[628]

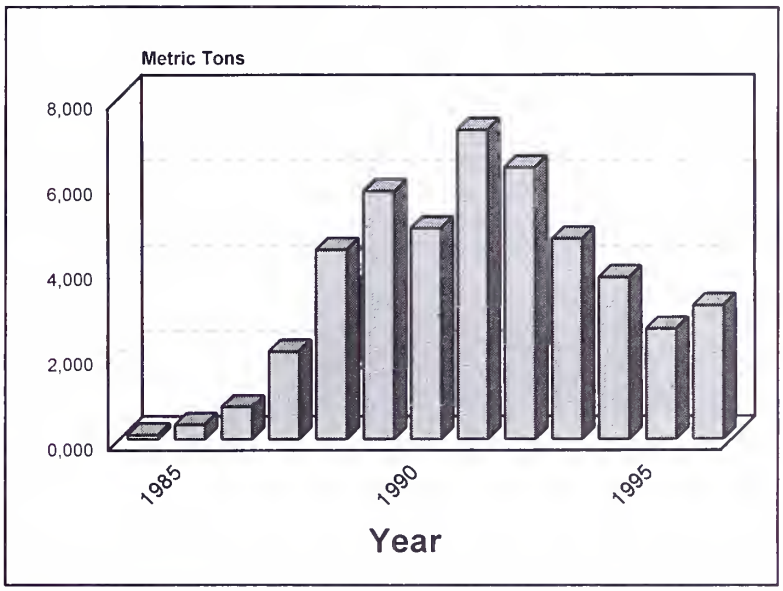

Figure 93.--The current Chilean fishery began in earnest during 1986 and after only a few years peaked in 1991. Catches have since fallen dramatically

1988: Many Chilean specialists believe the optimal period for the fishery was 1988-90.[629] One observer in 1988 reported that swordfish was one of the Chile's most profitable fisheries.[630] Many Chilean observers were optimistic about the expansion of the fishery.[631] The increased effort was accompanied by improved gear and fishing methods, greatly increasing fishing power. The driftnets permitted significantly increased catches compared to the traditional harpoon fishery because the species could now be targeted at night while feeding. Catches increased enormously in 1988, more than doubling to nearly 4,500 t (appendix E2a1 and figure 91). While catches continued to increase, this was only accomplished with greatly expanded effort--substantially reducing yields (appendices C2a1-2 and figure 55).[632] The fishermen began using satellite data to identify productive fishing grounds. (See: "Gear and Fishing Operations: Remote sensing" and "Research.") Commercial fishermen, impressed with the profitable artisanal operations, also began entering the fishery. Through the late 1980s, the fishing power of the fleet continued expanding as the artisanal fishermen deployed larger nets and commercial fishermen began deploying longlines (appendix C1a and figure 56). Much of the fleet had been composed of existing vessels, rerigged for driftnets. Chilean shipyards by 1988 were building boats specifically designed for swordfish. Marco launched, for example, the 15-m *Andrea* which was designed to deploy driftnets and harpoon swordfish.[633] Companies with foreign involvement, such as Pesquera Atún Mar and Pesquera Omega, reportedly played an important role in developing commercial longline operations for swordfish. Some Chilean companies noted that the expanding Chilean production was affecting prices on the U.S. market.[634] Periodic gluts in the Spring reportedly drove prices below $3.00 per pound ($6.60 per kg).[635] Prices to the fishermen plummeted from 1,400 pesos to only 500 pesos.[636] The fishermen upset with the falling prices offered by exporters staged a strike during May with about 300 boats participating.[637] Exports to the United States reached nearly 1,900 t (product weight in 1988 (appendix J3a1 and figure 140). IFOP and Fundación Chile worked with the major companies handling

swordfish to ensure that fish with high mercury content were not exported to the United States.[638] One U.S. importer indicated that in his opinion, mercury was not the greatest problem faced by the Chilean industry, but rather inadequate handling procedures.

1989: Commercial fishermen introduced a few longliners to the fishery in 1989-90, permitting offshore operations because several of the longliners were equipped with freezers. The commercial fishermen played an especially important role in expanding catches during 1989-91 (appendix E2f and figure 64). Commercial landings were initially a small part of the catch, until exceeding 1,000 t for the first time in 1989.[639] Companies reported extremely productive voyages. One company (Empresa del Estrecho) reported impressive catches of about 6 t per day.[640] Chilean artisanal and commercial fishermen landed over 5,800 t of swordfish in 1989 (appendix E2a1 and figure 91). Fishermen continued to build boats specifically designed for swordfish. One fisherman in 1989 launched a small vessel (the *Pelantaru*) designed for longlining swordfish and toothfish seasonally.[641] The boat was built as part of the CORFO-IDB project. Exports increased from only $3.8 million in 1986 to a then record $28.1 million by 1989 (appendix J2e and figure 131). Prices, however, declined (appendices G4a and J3a1 and figure 94). A U.S. fisherman did some experimental recreational fishing in 1988-89. While he reported some excellent fishing, he did not take fish anywhere near the size of the giants reported during the 1930s and 50s.[642] (See "Gear and Fleet Operations: Fleet operations.")

Photo 89.--Chilean longline fishermen by the early 1990s were making a major contribution to the country's swordfish catch. Eduardo Viveros Opazo

1990: Fishermen increased fishing effort enormously in 1990, nearly three times more than in 1989. Over 1,200 vessels with a fishing power of about 30 million square brazes (fathoms), about 0.1 square km, pursued the fishery (appendix C1a and figure 56). Despite this massive effort, the catch declined somewhat to only about 5,000 t (appendix E2a1 and figure 91) in 1990. Exports also declined slightly to $25 million (appendix J2e and figure 131). Prices continued to decline. Fresh product on the U.S. market averaged about $5.50 per kg, the lowest level since 1985 (appendix J3a1).[643] Many U.S. importers in 1990 began to anticipate price gluts beginning in May when fresh Chilean shipments begin to reach sizeable levels.[644] Chilean sources reported that some companies were having difficulty arranging for air shipment because many carriers reported available space was fully booked.[645] Given the declining yield, one report suggested that some artisanal fishermen began to consider withdrawing from the fishery. Many were reportedly concerned over the increasingly prominent role of the better-financed commercial fishermen (photo 89). Some observers are convinced that growing levels of commercial longlining after 1990 adversely affected stocks and artisanal yields because of the substantial take of juveniles by the commercial fishermen.[646] (See "Species: Size decline".)

1991: Artisanal fishing power continued at the same intense levels reported in 1990, 30 million square brazes, 0.1 square km (appendix C1a and figure 56). Another observer reported, however, a massive increase in another measure of effort, days at sea. Effort during 1991 reached nearly 37,000 days at sea--65 percent above 1990 levels (appendix C2a1 and figure 55).[647] One press report indicated that almost

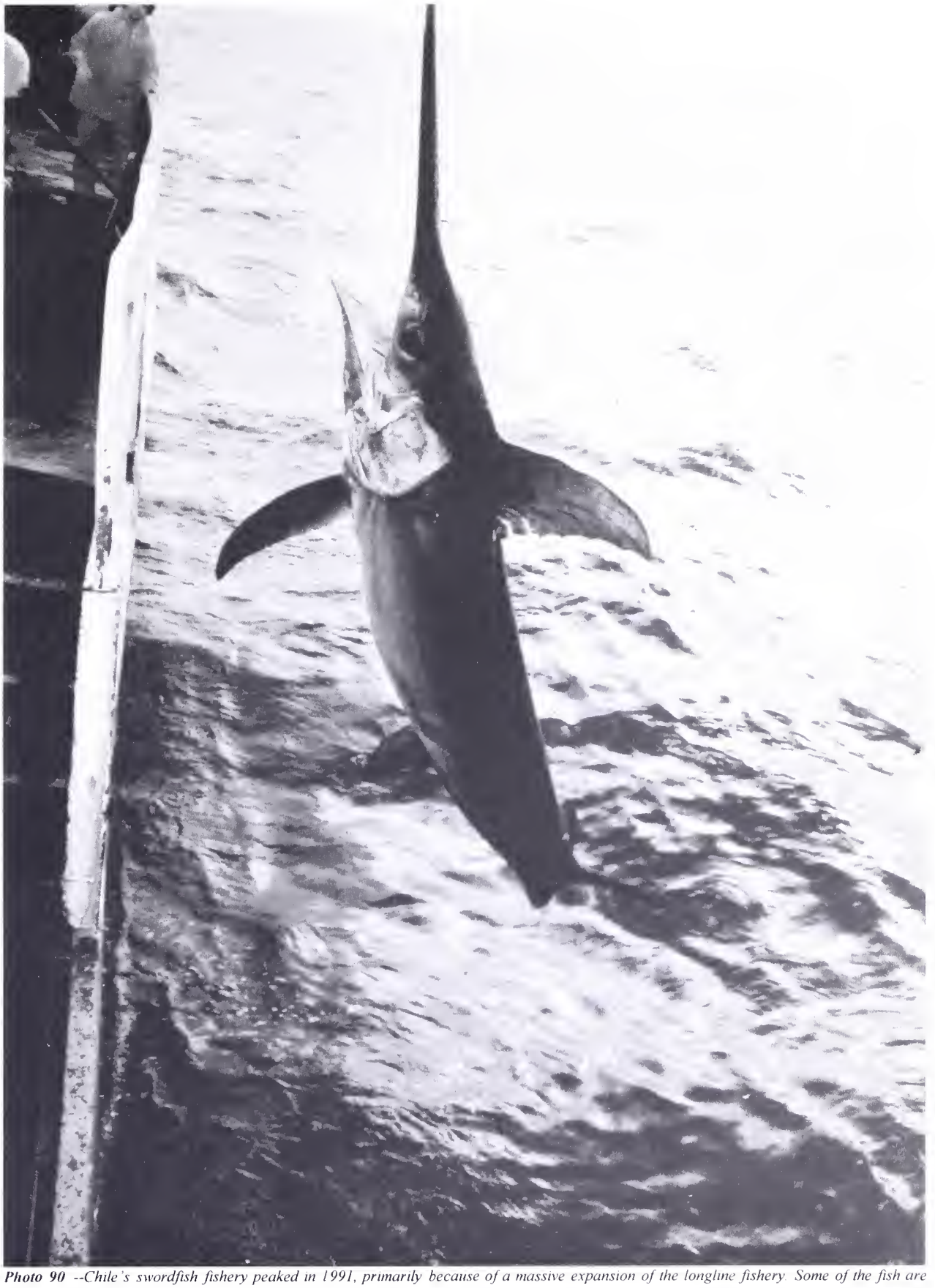

Photo 90 *--Chile's swordfish fishery peaked in 1991, primarily because of a massive expansion of the longline fishery. Some of the fish are still alive when brought aboard. Eduardo Viveros Opazo*

Photo 91 --The fish are beheaded and gutted at sea. Many commercial longliners have freezers, but now land mostly fresh product. On long trips, some of the catch will be frozen. E. Viveros O.

1,000 boats were deployed for swordfish.[648] Commercial fishermen continued expanding operations and the commercial catch exceeded the artisanal catch for the first time, totaling about 55 percent of the catch (appendix E2f and figure 64).[649] Factory vessel catches were reported for the first time in 1991 (appendix E2g and figure 65). The annual 1991 swordfish catch reached an all-time record level of nearly 7,300 t (appendix E2a1 and figure 91). Most of the catch increase was due to the expanding commercial longline fishery (photo 90). Exports also reached a record $40 million (appendix J2e and figure 131).[650] Prices for fresh product on the U.S. market recovered to over $6.40 per kg (appendix J3a1). Swordfish in just the space of a few years had become one of the country's most important fisheries producing edible product.

1992: Chilean fishermen reported that effort and yields leveled off in 1992 after several years of steady declines (appendices C2a1-3 and figures 55 and 57).[651] Effort during 1991-94 were little changed. Swordfish catches declined slightly in 1992, but were still an impressive 6,400 t (appendix E2a1 and figure 91). Both artisanal and commercial fishermen reported somewhat lower catches. Very significant price fluctuations were noted.[652] Commercial operations for the first time were conducted outside of Chile 200-mile zone (appendix E2g and figure 65). The artisanal fleet produced fresh product, but the commercial fleet continued to freeze most of its catch (photo 91). The commercial fleet by 1991-92 was landing over half of the country's catch (appendix E2f and figure 64). Exports continued at high levels--nearly $36 million, although somewhat below the 1991 record (appendix J2e and figure 131).

1993: The fishermen reported further yield declines in 1993 (appendices C2a1-3 and figures 55 and 57). Fishermen continued to describe an offshore displacement of the fishery and declining mean sizes

Photo 92.--Artisanal fishermen were reporting sharply reduced returns from the swordfish fishery by 1993. Dennis Weidner.

of the fish caught (appendices B5h1-4 and figure 48). Catches declined sharply. The fishermen caught only 4,700 t of swordfish in 1993 (appendix E2a1 and figure 91). Many fishermen reportedly withdrew their vessels from the fishery due to the 1992 catch decline and disappointing yields (photo 92). This withdrawal as well as declining yields both contributed to the sharp 1993 catch decline. Some observers believe that the 1992-93 El Niño may have exacerbated the catch declines.[653] The commercial fishery was especially affected. Commercial fishermen caught less than 2,000 t, a 45 percent decline from 1992 (appendix E2g and figure 65). These declines significantly reduced the earnings generated by the fishermen. Exports fell, as a result, to under $29 million (appendix J2e and figure 131). Actual export prices, however, increased (appendix J3a1).[654] Companies reported wide fluctuations in prices as a result of varying quantities marketed and the small size of the market.[655] The large fleet and falling prices greatly reduced the profitability of the fishery.[656] Most companies reportedly disappointing results. Despite the sharp decline, however, one company (Empresa del Estrecho) operating longliners reported excellent results.[657] The decline in the commercial catch was especially severe and commercial catches fell below the level of the artisanal catch (appendix E2f and figure 64).[658]

Photo 93.--Most commercial fishermen operating freezer vessels, responding to price fluctuations, have shifted operations to fresh product, especially after 1993. Herman Carvajal Leon

1994: The swordfish fishery continued to decline in 1994. Effort was relatively stable.[659] The fishermen reported steadily falling yields and landed only 3,800 t (appendix E2a1 and figure 91). The commercial catch in particular declined again. Several companies operating longliners reported especially poor results.[660] The commercial longliners, even the large freezer vessels, increasingly shifted to fresh product (photo 93). The artisanal fishermen, however, were not as severely affected. Artisanal catches were essentially stable from 1992-94 (about 2,600-2,800 t), despite the major catch declines reported by the commercial fishery (appendix E2g and figure 65). As a result, the relative importance of the artisanal fishery increased. Artisanal fishermen supplied nearly 70 percent of the catch in 1994 (appendix E2f and figure 64). Overall swordfish export shipments fell to only $23 million, less than 60 percent of the shipments at the 1991 peak (appendix J2e and figure 131). Prices were slightly lower than 1993 (appendices G4a and J3a1 and figure 94).

1995: Both the artisanal and commercial fleet reported substantial catch declines, but the commercial fleet was again particularly affected. Commercial catches totaled only 500 t, a decline of over 60 percent. Several companies ceased operations. Available data on effort shows mixed estimates (appendices C2a2-3 and figures 55 and 57). Many commercial vessels withdrew from the fishery. The 1995 commercial fishing pattern was relatively short, peaking in August (appendix E4b1 and figure 94). One report suggested that only six longliners were active.[661] As a result, the artisanal take counted for more than 80 percent of the overall catch (appendix E2f and figure 64). Overall swordfish catches fell to less than 2,600 t the smallest catch since 1987 (appendix E2a1 and figure 91). Export shipments, however, were relatively constant at about $21 million (appendix J2e and figure 131). Prices increased, but Chilean export data shows a much sharper increase than that shown by U.S. import data (appendices G4a and J3a1 and figures 94 and 150).

1996: Chilean fishermen reported a small catch increase in 1996, the first since the fishery peaked in

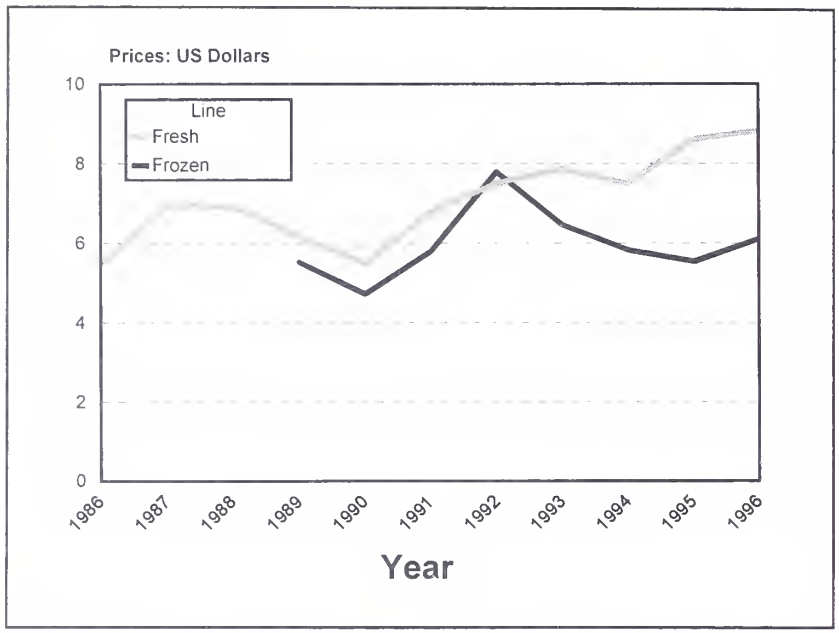

Figure 94.--Prices for fresh swordfish have increased since 1990, while frozen prices have been weak. This dichotomy explains the decision of commercial fishermen to shift to fresh products.

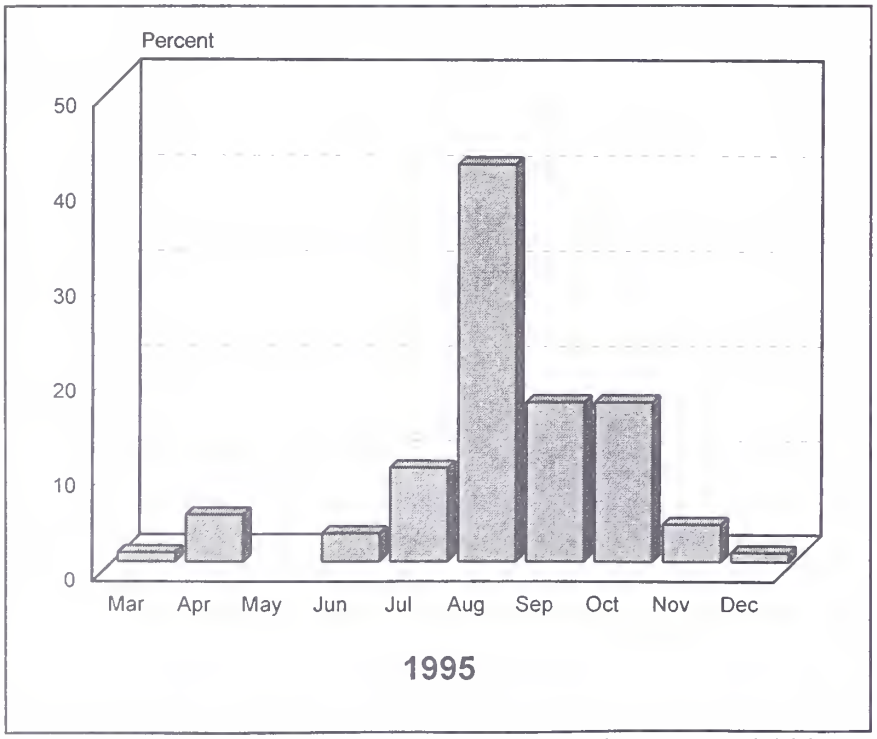

Figure 95.--Commercial fishermen experiencing falling prices and earnings curtailed fishing in 1995 to only a few months.

Photo 94.--The principal by-catch species is shark. IFOP researchers like Miguel Donoso have participated in the exchanges with NMFS to study swordfish and by-catch. NMFS

1991. Even more significantly, a major shift occurred in the makeup of the fishery. The fishermen reported a relatively modest reduction in effort (appendix C2a3 and figure 57), however, the artisanal fishermen reported sharply lower catches--only 600 tons. This suggests that many fishermen, at least for the season, withdrew from the fishery (appendix E2f and figure 64). The artisanal catch is not just a function of swordfish yields, but of a variety of other factors such as swordfish prices and prices for alternative species. The artisanal fishermen targeting swordfish fish other species seasonally and are quite capable of fishing other species even during the swordfish season. One local observer suggests that this is precisely what happened in 1996, many artisanal fishermen simply did not target swordfish because of more attractive prices for alternative species.[662] Another observer also believes that poor prices at landing sites, high prices for alternative species (especially toothfish), and increased operating costs because of the shift west to more distant grounds have adversely affected the artisanal fishery.[663] One vessel captain believes a prolonged period of bad weather during the prime fishing season impaired operations.[664] The artisanal fishing season was thus only active for a few months in 1996 (appendix E3a1 and figure 95). Commercial fishermen, on the other hands, greatly expanded fishing operations beyond the country's 200-mile zone (appendix E2g and figure 65). Particularly good fishing was reported by the commercial fishermen around the Juan Fernández Islands, but the artisanal fishermen in their small boats were unable to access these relatively distant grounds, about 1,000 km from the mainland coast. Overall the fishermen reported a 1996 catch of over 3,100 t, the first catch increase since 1991 (photo 94). One company reported relatively good results in 1996, but with yields of about 1 t of swordfish per fishing day, far below the results achieved in 1989.[665] The seasonal pattern of commercial fishing within 200-miles has been relatively consistent since the fishery began in the late 1980s (appendices E4a1-2 and figure 96). The seasonal pattern beyond the 200-mile is somewhat

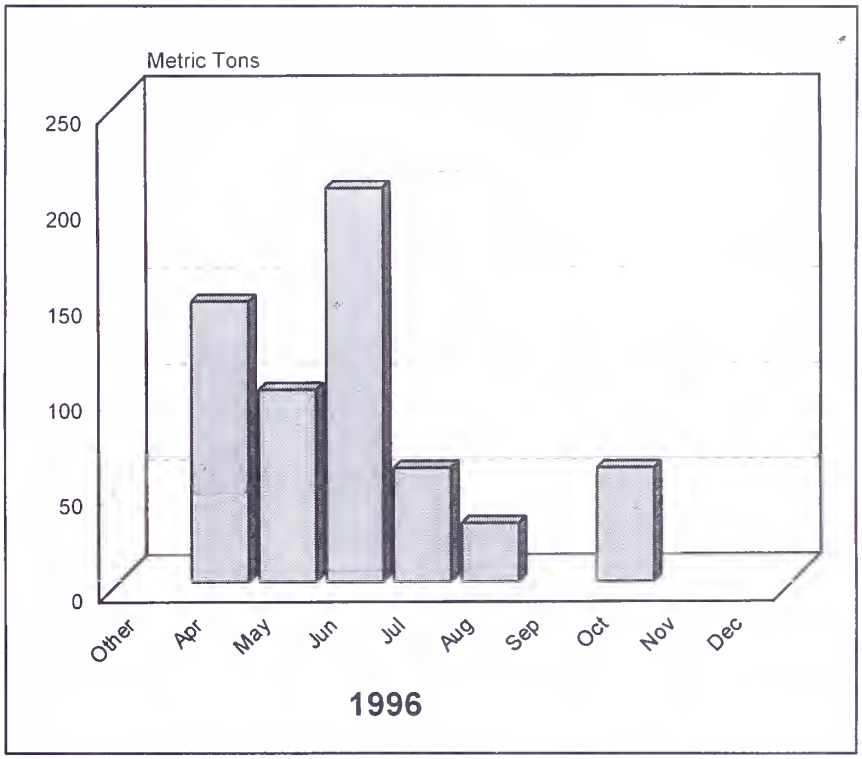

Figure 96.--Many artisanal fishermen in 1996 left the fishery or fished for only a few months, in part because of declining yields and favorable prices available for alternative species.

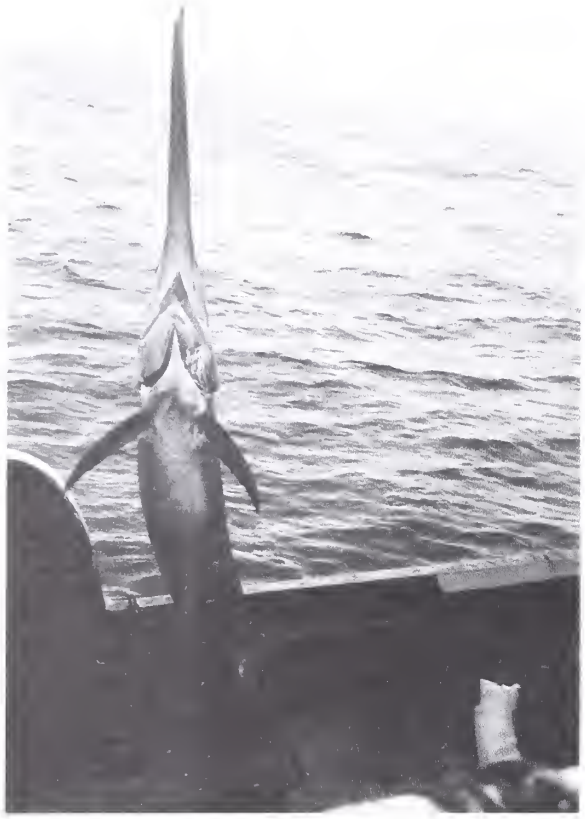

Photo 95.--Commercial longlining has enabled Chilean fishermen to access offshore south Pacific grounds. A few have even targeted distant south Atlantic grounds. H. Carvajal Leon

different, lasting longer in the season (appendices E4b1-2 and figure 97). The different seasonal pattern was notable in 1996 when the fishermen in operations within 200-miles reported good catches as early as April (appendix E4a1 and figure 98). The fishermen beyond 200-miles also reported some fishing in April, but continued fishing through December (appendix E4b1 and figure 99). Exports declined somewhat to $19 million (appendix J2e and figure 131). Chilean and U.S. data confirm prices at record levels of over $8.00 per kg (appendices G4a and J3a1 and figures 94 and 150).

1997: Some preliminary reports are available to the authors on the 1996 season. An unusually large Chilean shipment of frozen product was reported in January. SERNAP indicates that preliminary reports suggest the 1997 catch will be similar to 1996.[666] IFOP reports preliminary catches of about 2,100 t through July.[667] This would suggest a catch of about 3,000 t for the full year, about the same as 1996. Apparently the artisanal fishermen are having a somewhat better season as the have landed about 700 t while the commercial fishermen have only taken about 1,400 t through July. Some commercial fishermen are reporting good results, expanding operations around the Juan Fernández Islands (between Robinson Crusoe and Alejandro Selkirk Islands). One observer reported catches of 50 percent over 1996 levels.[668] U.S. imports suggest that catches may be running slightly ahead of 1996 results, even discounting the large January shipment of extremely low-priced frozen product (appendix J3g). Fresh prices have declined somewhat from the record 1996 levels (appendix J3a1). The impact of the powerful developing 1997 El Niño remains to be seen (figure 26). (See "Species: Temperature".)

b. Expansion (1986-91)

Chilean swordfish fishermen greatly expanded their catch during the late 1980s and early 1990s. The shift to modern gear and fishing methods appears to be the primary factor permitting the rapid increase, but several other developments also contributed.

Expanded fleet: Fishermen greatly increased the size of the fleet. An IDB fisheries development project helped artisanal fishermen purchase vessels during the mid-1980s. Many of the new vessels were deployed in the swordfish driftnet fishery.

Improved vessels: Not only were additional vessels deployed to the fishery, but the fishermen began acquiring larger more modern vessels. (See "Fleet.") Artisanal fishermen began ordering vessels of 15 m and larger to provide more stable fishing platforms, permitting operations further from the coast and in

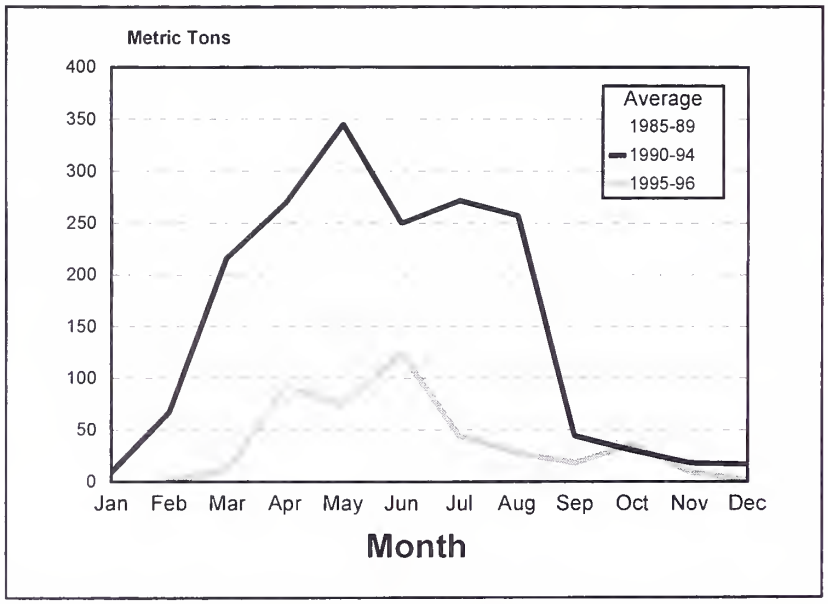

Figure 97.--Commercial fishermen since the late 1980s have reported a relatively consistent catch pattern within the Chilean 200-mile EEZ.

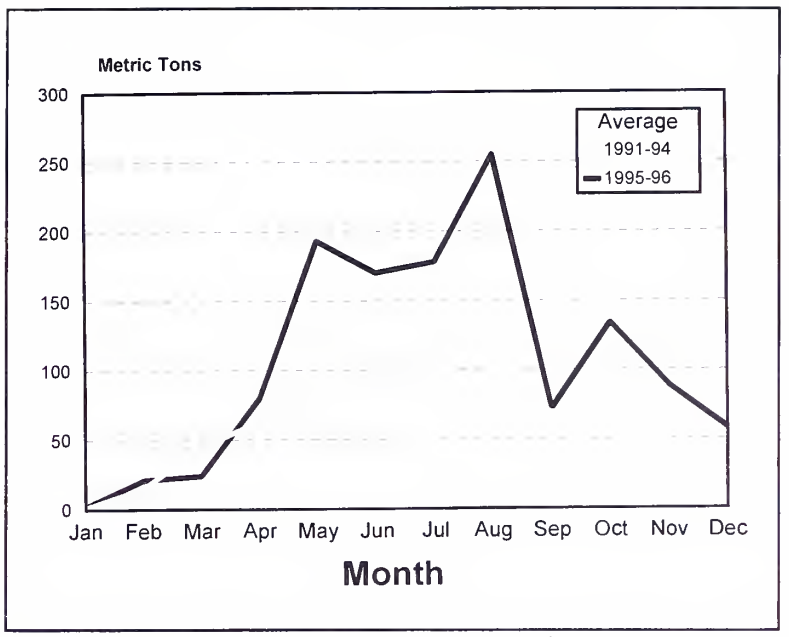

Figure 98.--Chilean fishermen operating beyond the 200-mile EEZ report a somewhat different seasonal pattern than within the EEZ, landing more fish later in the year

rougher ocean conditions.[669] These vessels were capable of larger catches and their greater endurance and range enabled them to extend the fishing season and to target previously unexploited grounds. In addition, several companies began to deploy even larger commercial longliners capable of highseas operations throughout the year (appendix A3b and photo 53). The large longline vessels also permitted operations during weather conditions in which the small driftnet vessels could not deploy their nets.

Improved gear: The most important factor permitting the expansion of the fishery was improved fishing gear.[670] Artisanal fishermen during the mid-1980s began to acquire modern fishing gear, especially monofilament driftnets. Not only were the driftnets more efficient, they also enabled the fishermen to lengthen the existing fishery based on harpoons from 3 to 9 months and for the first time target the fish below the surface while feeding. The initiation of commercial longline operations in the 1990s enabled the fishermen to further extend operations, especially to new offshore grounds (photo 95).

Mechanize operations: Artisanal fishermen began mechanizing their operations. Some of the artisanal fishermen installed hydraulic winches to help retrieve driftnets.[671] Most of the longliners already had hydraulic equipment.

Satellite data: Fishermen began to use satellite imagery. This data enabled them to locate temperature fronts where the nets could be most productively deployed. (See "Gear and Fleet Operations: Remote sensing.") This had the effect of significantly improving the efficiency of fleet operations by reducing unprofitable time spent seeking areas with appropriate conditions. The satellite data also expanded the area in which the fleet operated. Fishermen were apparently willing to make longer trips, even into distant offshore waters, if they could be sure of encountering promising fishing conditions.

U.S. market: The popularity of swordfish in the United States and the open trade policies of the U.S. Government provided a ready market for Chilean exporters. As a result, fishermen found they could readily market their expanding catch in the United

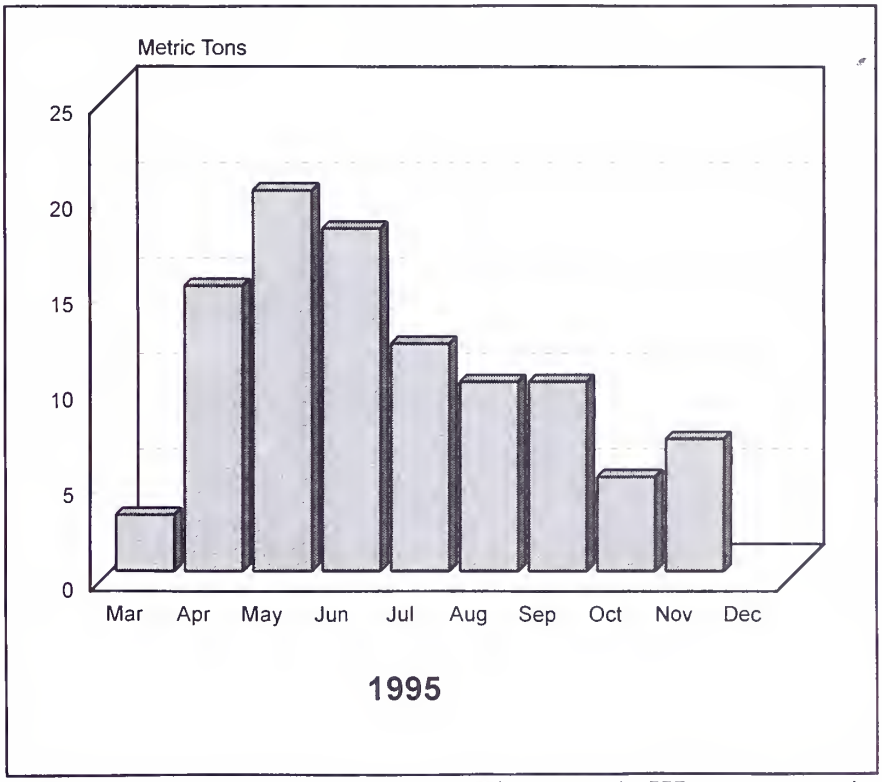

Figure 99.--Commercial fishermen operating beyond the 200-mile EEZ report a somewhat different seasonal pattern than within the EEZ, landing more fish later in the year.

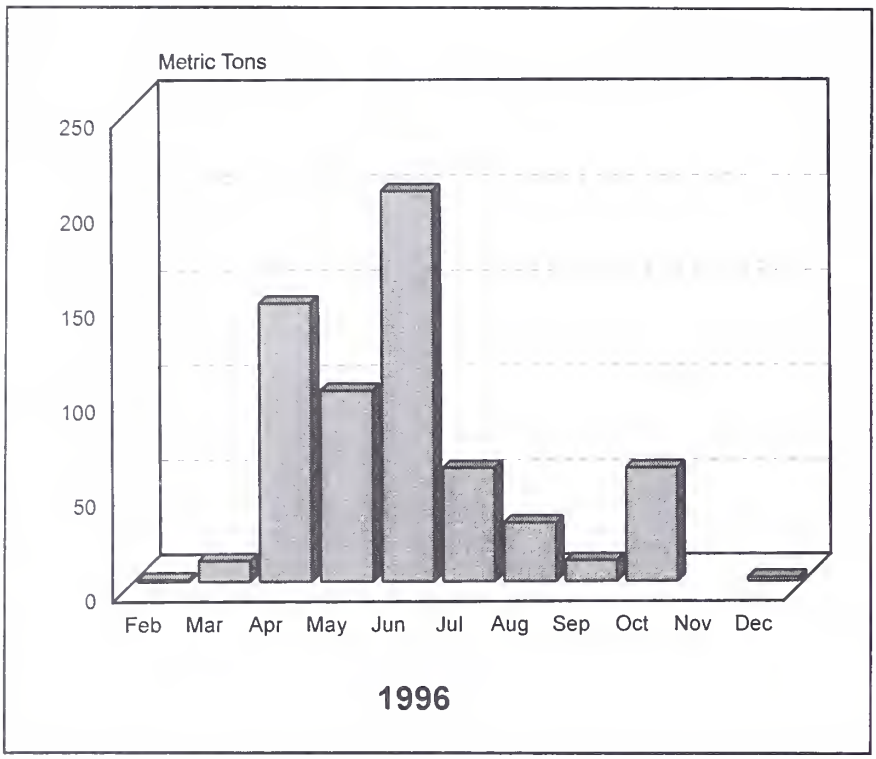

Figure 100.--Commercial fishermen outside of the 200-mile EEZ began landing significant quantities in April and substantial landings continued through December.

States at attractive prices--much higher then they had previously obtained on the domestic market.[672] The large size of the U.S. market, in addition, meant that even substantial increases in Chilean exports appears to have had only a small impact on prices (appendix J3a1).[673]

Government assistance: Chilean Government promotion programs aided both the fishermen and processing companies. The Chilean Government with assistance from the Inter-American Development Bank (IDB) during the mid-1980s helped artisanal fishermen modernize existing vessels and acquire larger new vessels.[674] The Government assistance to artisanal fishermen was a major factor in the rapid expansion of the fleet during the late-1980s (appendices A2b1-3 and figures 73). Many fishermen deployed their new vessels seasonally in the swordfish fishery. In addition, the Government offered export incentives to processors during the 1980s. (See: "Government Agencies and Policy.")

c. Decline (1991-95)

The precipitous decline of the Chilean catch since 1991 is not fully understood (appendix E2a1 and figure 91). (See "Species: Stock status.") Industry observers offer a variety of possible explanations. There clearly is a declining availability of fish to the fishery. One or more factors could be involved. Many observers point primarily to the massive fishing pressure deployed off Chile. (See "Species: Fishing effort.") Overfishing does appear to have occurred. Climatic fluctuations are another possibility. Some economic factors may also be involved. Lower yields, for example, may be causing the fishermen to withdraw from the fishery because of declining profitability.

Over fishing: The factors discussed above leading to the rapid expansion of the catch during the late 1980s may have caused the fishermen to exceed the maximum sustainable yield (MSY). While it is clear that fishing effort increased enormously (appendices C2a1-3 and figures 55-57), the lack of data on the status and structure of stocks off Chile make it impossible to conclude definitely that Chilean fishermen are exceeding the MSY.[675] Many observers are convinced, however, that overfishing is the primary reason for the decline.[676] Data from the fishery show every sign that the species is being overfished. The parabolic pattern of the catch increase and subsequent decline is an almost textbook curve often associated with overfishing (appendices E2a1-2 and figure 91). Government officials and researchers have reported declining average sizes and yields (appendices B5h1-4 and figure 48). Fishermen are having to make longer and longer trips.[677] (See "Fishing Grounds.")

Aging fleet: Many fishermen, especially the artisanal fishermen, operate relatively old vessels. The declining catches and profitability of the fishery after 1991 has made it difficult to continue improving their vessels or replacing the older ones.[678] These older vessels are proving increasingly costly to operate and maintain.[679] Increased operating costs and declining yields would explain the withdrawal of vessels from the fishery.

Government incentives: The Chilean Government export incentives (draw backs) were designed to assist small, new (non-traditional) operations. As the new industries develop, the incentives were lowered and finally terminated. (See "Government Agencies and Policies.") The withdrawal of swordfish from the export incentive program made swordfish products less profitable.[680] The authors are unsure of

Photo 96 *--The commercial longline fleet reports substantial catches of very small swordfish. These headed and gutted fish are ready to be stored in the ice hold. Herman Carvajal Leon*

precisely when swordfish was removed from the qualifying list of non-traditional products, but believe it was in effect for only a brief period. One report suggests the 10 percent incentive was eliminated as early as 1988.

Exchange rates: The strengthening of the Chilean peso in recent years has reduced the value of export earnings, making this export oriented fishery less profitable to domestic companies.[681]

Commercial longlining: Artisanal fishermen and some researchers and Government officials criticize the commercial longliners operating off Chile, both domestic and foreign. These vessels can fish year round and significantly increased fishing pressure on stocks, especially during the early 1990s. The commercial fishermen also reported a very substantial catch in 1996 (appendix E2f and figure 64). Available data indicates that commercial longliners are reportedly taking very small fish, in some cases fish as small as 17-19 kg (appendix B5g3 and figure 29).[682] This substantial take of juvenile fish is especially troubling to many observers who blame the commercial longliners for much of the catch decline (photo 96).[683] (See "Species: Stock status.")

Artisanal fishermen: Chilean sources are generally less critical of the artisanal fishermen. This is in part due to a Government social policy supporting small-scale fishermen. The impact of the artisanal fishermen, however, almost certainly has also played a role in the catch decline since 1991. The artisanal fishery has taken more fish in most years than the commercial fishery. In addition the artisanal fishermen have taken more adult fish capable of spawning. While most fishery management systems protect juvenile fish, there is a body of thought suggesting that a more effective management system would be to protect the adult spawning fish. The higher natural mortality of juvenile fish means that many of the protected juveniles are lost to the fishery anyway.

Foreign fishing: Foreign fishermen are also taking swordfish in the eastern Pacific outside of the Chilean 200-mile zone. This effort is facilitated by Peru which allows foreign fishermen operating in the southeastern Pacufic access to its ports.[684] Without access to Peruvian ports it would be difficult for the Spanish in particular to fish swordfish in the southeastern Pacific. Unlike the Japanese the small Spanish companies do not deploy motherships to sustain operations in distantwaters. Even the Japanese make some use of Peruvian ports. Chilean fishermen are most concerned with Spanish fishing as they are targeting swordfish. The Spanish activity on the Nazca Ridge, where large number of juveniles are taken, is especially troubling to the Chileans.[685]

Environmental conditions: Changing environmental conditions are another possible cause of the decline in the fishery since 1991. (See "Species: Stock status.") Some regional observers believe that El Niño events as well as long-term climatic trends may have affected swordfish catch trends.[686] It is difficult to say at this time, however, if El Niño events are affecting abundance or distribution or both. There has not been a powerful El Niño event in the Eastern Pacific since the current Chilean artisanal and commercial fishery developed in the late 1980s. As a result, the potential impact on the current swordfish fishery remains to be seen. The result may be different than the impact on the harpoon fishermen which were limited to a narrow coastal strip because of the limited range of their mall boats. The current Chilean fleet, especially the commercial fleet, has the capability of ranging all along the Chilean coast as well as substantial distances west into the Pacific. Chilean observers are following the impact of the massive El Niño developing in 1997 with considerable interest.

Pressure on fodder species: Chile's large fishmeal industry is removing vast quantities of small pelagic species from the ecosystem. The Chilean fishery heavily targets jack mackerel which is a species swordfish are known to feed on, especially in coastal waters. The impact almost certainly is affecting predator species, like swordfish, higher up on the food chain. (See "Species: Stock status.") Such assessments, however, are difficult until more is known about swordfish feeding habits off Chile.

VIII. Ports

Chilean vessels operate from several different ports along the central and northern coast. The fleet is highly mobil with all but the smaller vessels following the swordfish and operating from different ports as the fish move north along the coast during the season. The great bulk of the catch, however, is landed along the central coast in a small number of ports. In most recent years the catch has been primarily landed at San Antonio (Region V) and Talcahuano and surrounding ports (Region VIII). Constitutión (Region VII) has been of some importance in a few years (appendices E2e1-2 and figures 66 and 100). Substantial annual variations can occur (figures 100-101). The ports used varies somewhat by the fishery, but is largely determined by the need to land fresh fish close to the Santiago international airport for air shipment to the United States.

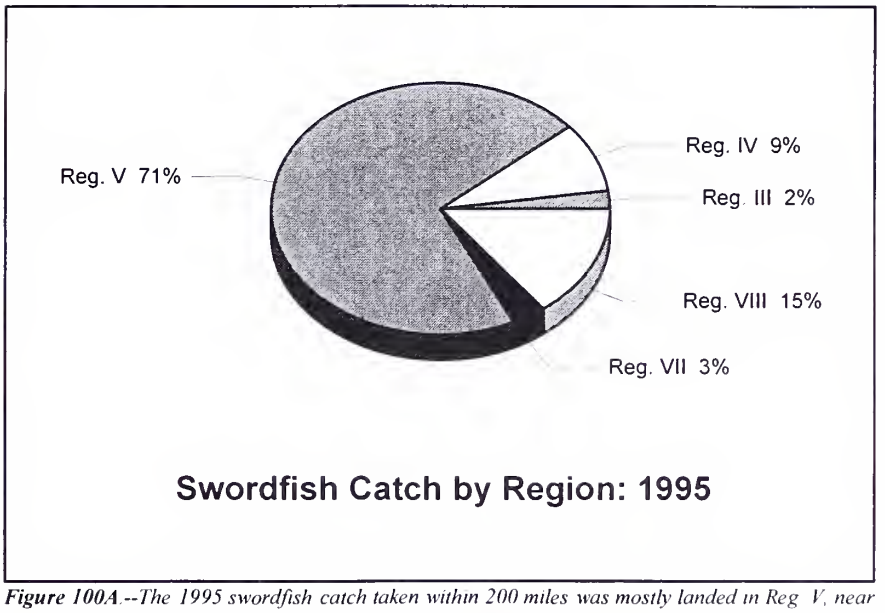

Figure 100A.--The 1995 swordfish catch taken within 200 miles was mostly landed in Reg. V, near Santiago. Reg. IV's importance is understated as catch beyond 200-miles is mostly landed there.

Commercial longliners: The longliners mostly operate out of Coquimbo, and to a lesser extent Valparaíso and San Antonio. All of these ports are well situated close to the grounds they target.

Artisanal driftnet vessels: The driftnet vessels operate from a larger number of ports. They may call at several different ports during any one season. All but the smallest vessels are capable of easily shifting operations from one port to another.[687]

The swordfish fishermen at present primarily use ports located along the country's central coast. The major swordfish port is San Antonio. Chilean fishermen normally land anywhere from 45-70 percent of their catch taken within the 200-mile EEZ at Region V and most of that is landed at San Antonio (appendix E2e1 and figure 100). San Antonio is important for two reasons. First, it is located along the central coast where much of the swordfish is taken. (See "Fishing Grounds.") Second, it is close to the

Photo 97.--Arica is a free port. It is Chile's northern-most and used by several distant-water fishing nations to transship fish taken in the southeastern Pacific. SERNAP

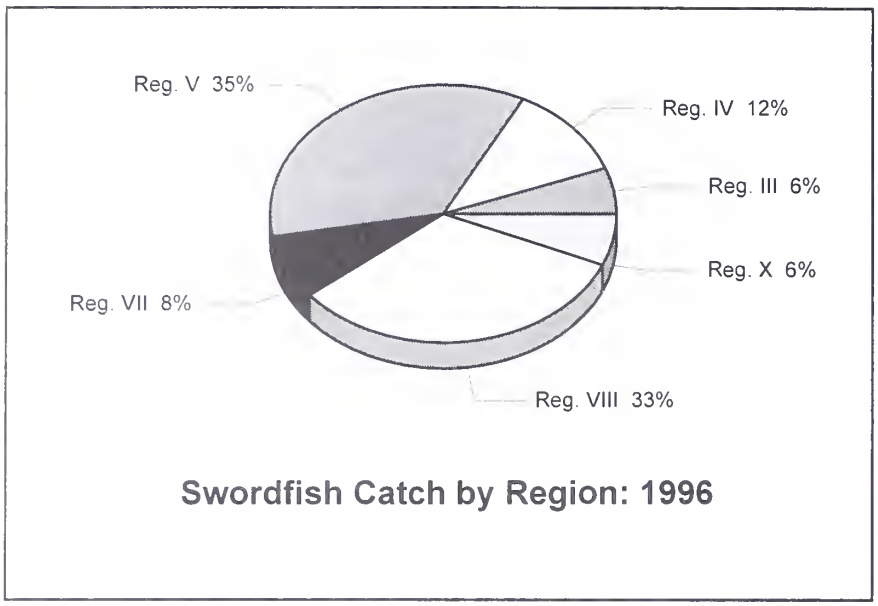

Figure 101.--Reg. V was also important in 1996, but Reg. VIII ports increased in importance during 1996. This data does not include the large catch beyond the EEZ, much of which was landed in Reg. IV.

Santiago A. M. Benítez International Airport through which fresh swordfish is air freighted to export markets. Ports in Region VIII are also important, and in some years rival Region V landings (appendix E2e1 and figure 101). The Region V landings are scattered among several sites, including Lebu, Talcahuano, Coronel, and San Vicente (appendix F4 and figure 102). Landings at the Region VIII ports usually total about 10-25 percent of the catch. The only other major landing site is Coquimbo in Region IV where about 10 percent of the catch taken within 200 miles was landed during 1996 (appendix E2e1 and figures 100-101).[688] Coquimbo is particularly important to the commercial fleet. Small quantities of swordfish are landed in several other ports, including Caldera (Region III), Constitución (Region VII), and Valparaíso (Region IV). Port and regional landings in individual years can differ significantly from the norm (appendix E2e1).

Detailed time-line data for fishing activities by port are not available to the authors. Some details are available for 1991 showing activity at the peak of the fishery (appendix F1). The data indicates that the most trips were out of San Antonio (figure 103); landings were highest at San Antonio, Lebu, and Constitución (figure 104); trip length longest out of Constitución (figure 105), and the best yields reported out of Lebu and San Vicente (figure 106).

Details on activities at specific ports include:

Antofagasta: Antofagasta is a major industrial port located in Region II. It is an important port for the country's fishmeal industry. It was also an important port for the small-scale harpoon fishermen operating in the 1940s. Swordfish operations from the port as well as landings, however, are currently minimal (appendix E2e1 and figure 66).

Arica: Arica is Chile's northern-most port, located close to the border with Peru in Region I at 18°20'S (photo 97). It is an important fishing port focusing primarily on the reduction fishery, but there is also some limited artisanal fishing (photo 98). Harpoon fishermen landed swordfish at Arica in the 1940s and 50s, but virtually no swordfish is now landed there. This is in part due to the decline of the northern harpoon fishery. (See "Catch.") Another factor is the substantial distance to the Santiago airport. Arica is

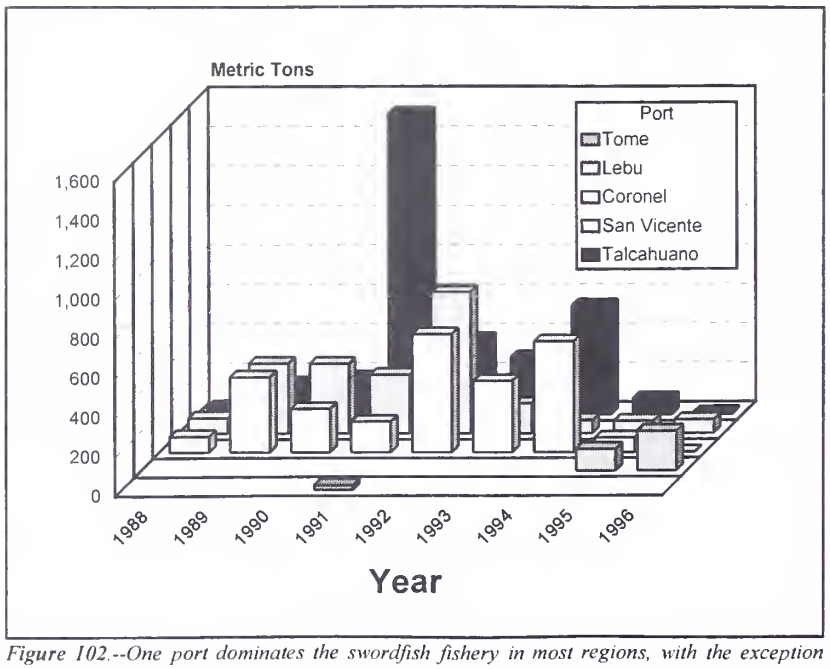

Figure 102.--One port dominates the swordfish fishery in most regions, with the exception of Region VIII. The ports in that region fluctuate in importance from year to year.

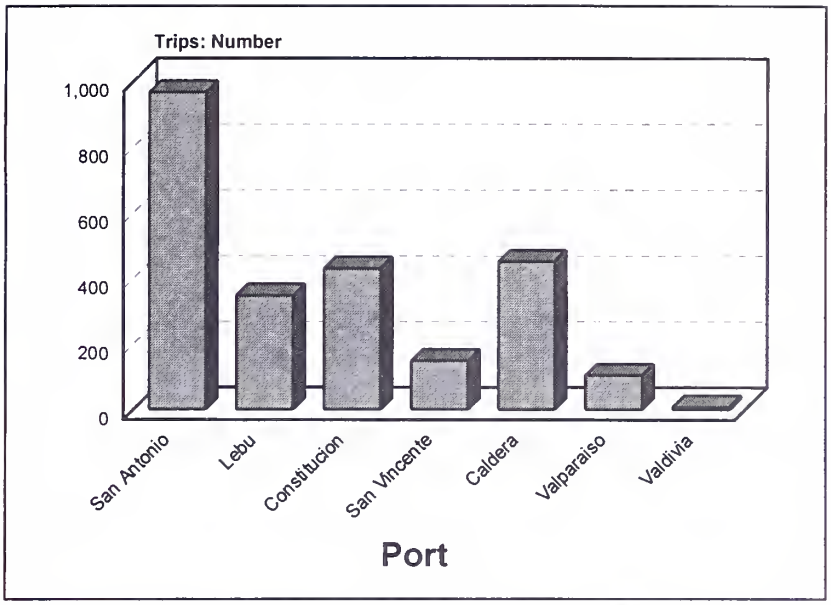

Figure 103.--In many years like 1991 at the peak of the fishery, between half and one-third of all trips are conducted from San Antonio.

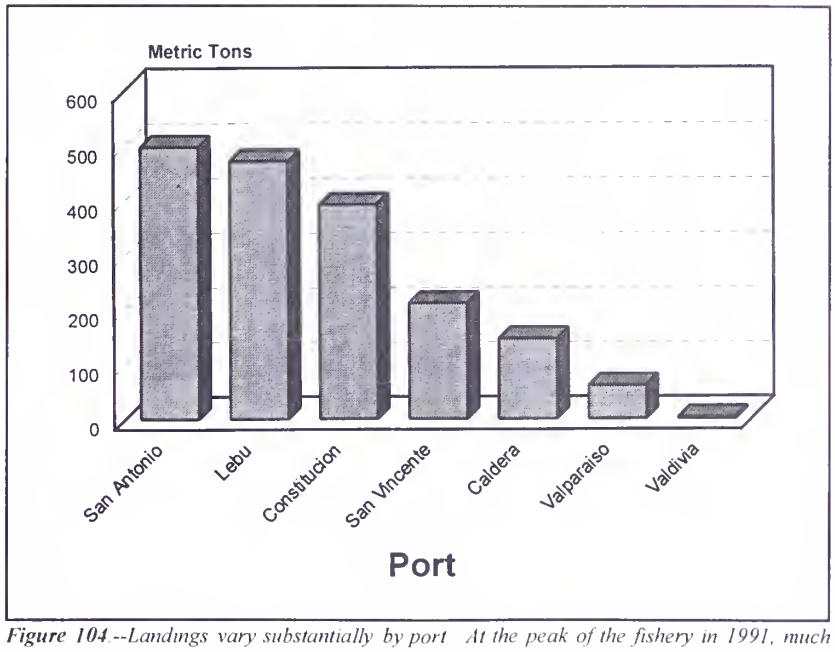

Figure 104.--Landings vary substantially by port. At the peak of the fishery in 1991, much of the catch was landed at three ports.

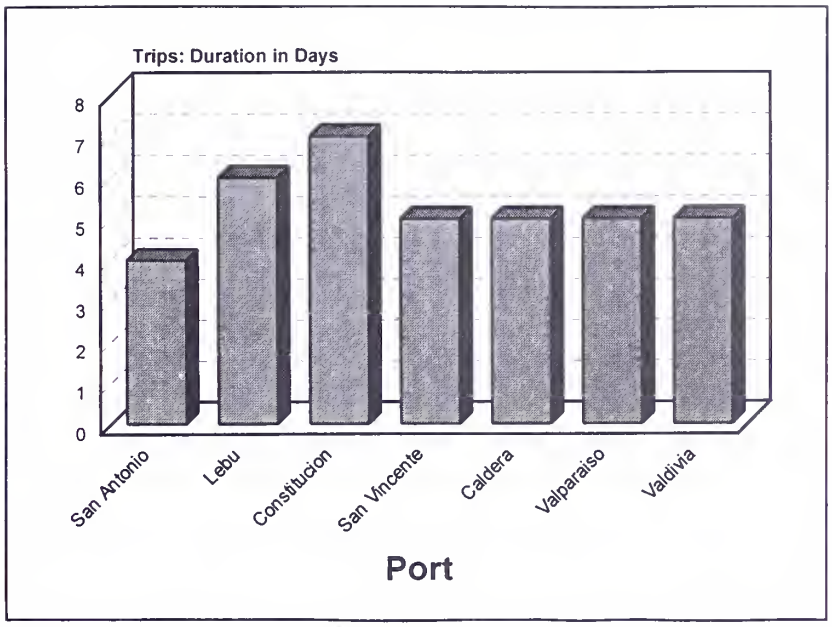

Figure 105.--Trip duration is relatively similar among major ports. The longer trips reported by Constitución fishermen may be due to the number of longliners based there.

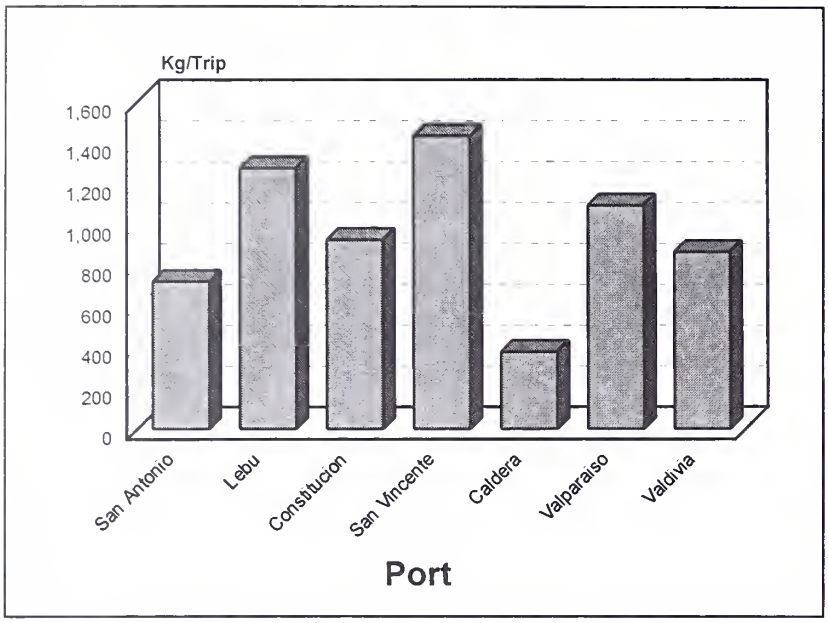

Figure 106 --Yields vary substantially by port, notably yields reported by San Antonio fishermen at the peak of the fishery in 1991 were relatively low.

80 vessels were based there in 1991 (appendix A2e). More recent data for 1995 indicates that nearly 60 artisanal vessels operated from Caldera (appendix A2d2 and figure 32). Most of the vessels are driftnet vessels, but a few still occasionally use harpoons. The number of vessels fluctuate significantly on a seasonal basis. Only a handful of vessels, for example, operated from Caldera during at least some months of 1994 (appendix A2d1 and figure 86). Many Caldera-based vessels, however, do not land their catch there. Since 1990, only a small part of the swordfish catch has been landed in Region III, all at Caldera (appendices E2e1-2 and figure 66). The commercial fishermen operating off northern Chile have instead tended to use Coquimbo to the south.

nearly 2,100 km north of Santiago and it would take about 20 hours to truck the catch to the Santiago airport. The catch could be flown to Santiago, but this would increase costs. As a result, even though the longliners operate extensively off the northern coast, most land their catch further south at Coquimbo or San Antonio--in part to facilitate shipment of the highly perishable fresh swordfish. Some of the Spanish, Taiwan, and Panamanian tuna/swordfish longliners operating in the eastern Pacific call at Arica for supplies and services. The foreign fishermen are not allowed to transship their swordfish catch.[689] They are, however, allowed to transship tuna and several other species. (See "Transshipments.") The foreign fishermen, especially the Spanish, instead use the nearby port of Ilo and other Peruvian ports (photo 99).

Caldera: Caldera is located at about 27°N in Region III. The fishing sector is one of the most important local industries.[690] It is the northern-most port from which swordfish operations are currently conducted. Approximately

Constitución: Constitución is located at about 36°S in Region VII. The port is usually of only limited importance to the swordfish fleet, but in some years activity at the port has been substantial. Nearly 70 swordfish vessels, for example, were based there in 1991 (appendix A2e). The number during 1994-95, however, never exceeded 14 vessels (appendices A2d1-2 and figure 32). As with other ports, vessels from Constitución often fish seasonally from other ports (photo 100). Some swordfish is landed in

Photo 98 --A small area at Arica is set aside for both artisanal and commercial fishing vessels. SERNAP

***Photo 99** --Swordfish is not one of the species foreign fishermen are allowed to transship through Arica, so the fishermen use Ilo and other Peruvian ports. José Echeandía Zegarra*

Region VII, all at Constitución. Landings in some years exceeded 10 percent of the Chilean catch, especially during the early years of the fishery. The fleet's use of Constitución, however, has declined in recent years. Landings in 1995 and 1996 were only about 3 percent of the Chilean catch (appendices E2e1-2 and figure 66). SERNAP reports that 16 small longliners were based at Constitución during 1996.[691] Most of the vessels are capable of taking both swordfish and demersal species, depending on the gear deployed. Six took some swordfish during 1996.[692]

Coquimbo: Coquimbo is located at 30°S in Region IV. It is about 465 km north of Santiago. Coquimbo is an important industrial port, its deep-water facilities are heavily used by the mining and agricultural sectors. Coquimbo has become the major Chilean port north of Santiago where the swordfish fishery is significant. Previously little swordfish was landed at Coquimbo. Many fishermen believed that the prevalent cold water temperatures and high plankton biomass off Coquimbo were not condusive to swordfish. Researchers at the Universidad Católica del Norte in Coquimbo, however, began assessing the use of satellite data to detect warm water plumes off Coquimbo where swordfish could be targeted.[693] The fishermen have since reported improved results. Coquimbo was the primary base for the commercial longliners during 1994-95 (appendices A2d1-2 and figure 32). SERNAP reports that about 10 percent of Chile's overall swordfish catch within 200-miles during 1990-94 was landed at Coquimbo (Region IV) (appendices E2e1-2 and figure 66). Actually a much larger portion of the catch is landed there, but fishermen are not currently required to report their catch taken beyond 200-miles, which in some years is significant. Much of the commercial catch taken beyond 200-miles is landed at Coquimbo. Given the large catch reported beyond 200-miles in 1996, this significantly affects the pattern shown by available data. Both the artisanal driftnet vessels and commercial longliners land at Coquimbo, but the longliners have been particularly active at Coquimbo during recent years (photo 101).[694] The commercial fishermen normally land about 20 percent of the longline catch taken within the 200-mile EEZ at Coquimbo (appendix E4d1 and figures 71 and 72). The longliners deployed outside 200-miles also use Coquimbo extensively, but no port landing data is available.[695] Such data, especially for 1996, would have shown that a very large portion of the overall catch was landed in Coquimbo. The principal advantage of Coquimbo is that it is a north/northcentral port located relatively close to the

Photo 100--Chilean artisanal vessels, like these driftnetters, may be based in any port, but land their catch in another port, in this case San Antonio. Dennis Weidner

commercial longline grounds off the north/northcentral coast. It is also not as busy a port as San Antonio which makes it easier to enter and often obtain immediate access to the commercial pier.[696] The principal port facility at Coquimbo is a 378-m long concrete pier which accommodates large cargo vessels with drafts of up to 10 meters.[697] The large commercial longliners also use this pier (photos 12, 46 and 102). The smaller artisanal vessels, however, use the somewhat congested facilities at the nearby San José artisanal fishing port (photo 103). The Empresa Portuario is studying the possibility of building a dedicated fishing port, but that will require financing from the fishing industry which has to date not taken the necessary steps to initiate such a project. Two of the most important companies involved in the swordfish fishery (Pesquera Omega and Empresa del Estrecho) have swordfish operations based in Coquimbo. Both of these companies operate longliners. There is little processing of swordfish at Coquimbo, although some fresh production has been reported since 1994--mostly fresh product (appendix G3d and figures 107-109). Pesquera Omega has reportedly processed small quantities. Local groups, however, are studying the possibility of value added processing.[698] For the most part, the trunks are simply landed, cleaned, loaded into cardboard boxes, and trucked to the Santiago international airport, about a 6-hour drive (photo 104).

Coronel: Coronel is one of the fishing ports in the Talcahuano area of Region VIII where swordfish is landed. As in Talcahuano proper, the primary activity is fishmeal reduction and to a lesser extent canning.[699] The primary target species is jack mackerel. The swordfish vessels are not based in Coronel, but as much as half of the landings in Region VIII are sometimes landed at this port (appendix F4 and figure 102).

Iquique: Iquique is located in Region I along the northern coast at 20°S. It is one of Chile's most important fishing ports accounting for significant small pelagic landings

Photo 101.--Coquimbo's large cargo pier is used by commercial longliners. Dennis Weidner

***Photo 102**--The commercial longliners use the main pier at Coquimbo. Note tail fins at the bottom of the picture which are cut off after unloading. Herman Carvajal Leon*

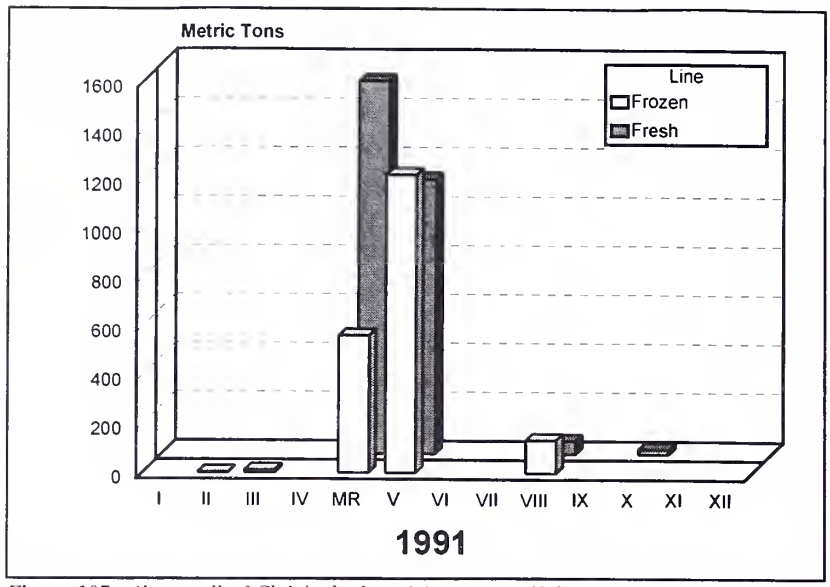

Figure 107.--Almost all of Chile's fresh and frozen swordfish production during the 1991 peak of the fishery was reported in Reg. V (San Antonio) an the Santiago metropolitan area.

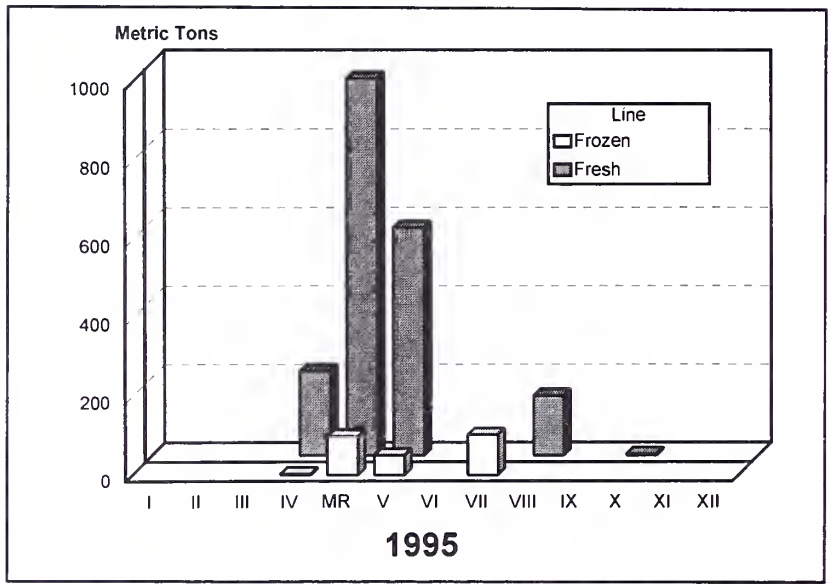

Figure 108.--Swordfish production by 1995 had shifted to fresh product and activity had increased at Coquimbo (Reg. IV) and Talcahuano area ports (Reg. VIII).

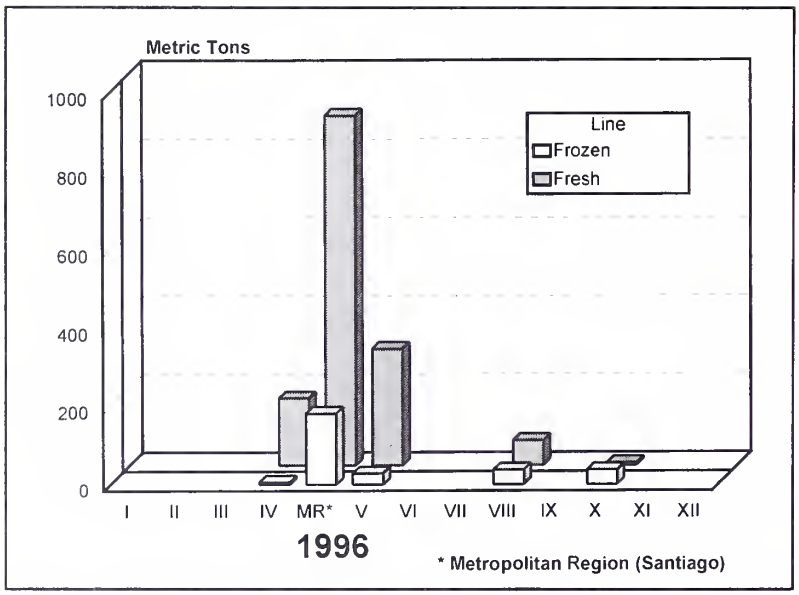

Figure 109 --Most of Chile's fresh swordfish production during 1996 was reported in the Santiago metropolitan area, but San Antonio (Reg. V) and Coquimbo (Reg. IV) were also important.

***Photo 103.**--Artisanal vessels at Coquimbo use a small, congested pier. Dennis Weidner*

***Photo 104.**--Trucks are waiting for the longliners at Coquimbo so that fish product can be quickly transported to the Santiago international airport. Herman Carvajal Leon*

Photo 105.--Iquique was once the center of Chile's harpoon fishery, but now little swordfish is landed there. Note the "tangon" in the foreground. Richard Schaefer

which are used to supply fishmeal plants. Until the development of the fishmeal industry in the Talcahuano area, Iquique was Chile's most important fishing port. Small-scale artisanal fishermen landed substantial quantities of swordfish at Iquique during the peak of the harpoon fishery in the 1940s. Recreational fishing was also reported during the 1930s-50s (photos 25,39, and 83-55). The port is not now extensively used by either the longliners or driftnet vessels and virtually no swordfish is now landed there (appendix E2e1 and figure 66). A few small swordfish vessels can occasionally be seen there (photo 105).

Lebu: Lebu is another small fishing port in Region VIII, located at about 36°S. It is about 20 km north of Talcahuano, Chile's most important fishing port. Approximately 65-95 vessels were deployed for swordfish from the port during 1991-93 (appendices A2c1-2 and A2e and figure 85). Data for 1994-95 suggest that the largest number of vessels operating out of Lebu was about 65 (appendices A2d1-2 and figure 86). As in other Region VIII ports, the vessels are especially active early in the season (appendices A2d2 and A2c1-2 and figures 32 and 85). Swordfish activity from Lebu, unlike most other Chilean ports increased in 1993. Lebu is a relatively small port and facilities are limited. While quite a number of vessels operate from Lebu, they tend to land little of their catch there (photo 106). Sometimes more than 25 percent of the Chilean swordfish catch is landed in Region VIII ports, but generally not at Lebu. Active Region VIII ports include: Coronel, San Vicente, and Talcahuano (appendix F4 and figure 102). Some landings at Lebu, however were reported for the first time in 1995.

San Antonio: San Antonio, located in Region V at about 34°S, is one of Chile's major industrial ports. San Antonio and Valparaíso are the two principal cargo ports for Santiago.[700] The port is about 110 km or a 1½-hour drive from Santiago. Swordfish

Photo 106.--These Lebu-based driftnetters worked out of San Antonio during 1996. Dennis Weidner

Photo 107.--San Antonio is the most important port for the artisanal swordfish fleet. The artisanal fishermen shifted to mostly demersal species in 1996. Dennis Weidner

fishing out of San Antonio began in the 1950s when the port facilities for fishermen were very limited.[701] The Government sponsored a major expansion of the fishing fleet and port in the late 1980s and early 1990s. The expansion occurred primarily in the early 1990s after the Government restricted expansion of the fishmeal industry in the north.[702] The most important fishing activity at San Antonio is the production of fishmeal and the port has some of Chile's largest and most modern reduction plants (photos 7, 16-17, 28, 33, and 38). San Antonio is also one of Chile's major swordfish ports and is heavily used by both the artisanal and commercial fleets (appendices E3b1-2 and E4d1-2 and figures 22 and 71). The port has advantages for both artisanal and commercial fishermen (photos 13, 32, 45, 62, 73, and 88). It is located along the central coast where much of the artisanal catch is taken. The location close to the Santiago international airport is a significant advantage as most of the catch is marketed fresh. Fish landed at San Antonio can normally be trucked to the airport in about 1½ hours (photo 107).

About two-thirds of the swordfish fleet operating off central Chile, the principal fishing ground, is based in San Antonio (appendix A2d1 and figure 86). Country-wide data suggests that seasonally as much as half of Chile's overall swordfish fleet operates from San Antonio (appendices A2d2 and A2e and figure 32). Nearly 40 percent of the swordfish fishing trips were conducted from San Antonio in 1991 (appendix C1b4) and over 60 percent in 1992-93 (appendix C1b2). Reports during 1994-95 confirmed that San Antonio continues to be an important port for the fleet, but not as dominant as in earlier years (A2d1-2). Swordfish operations out of San Antonio are highly seasonal. (See "Species: Seasonal variations.") As a result, monthly fluctuations in the numbers of vessels operating from the port can be significant. Over 170 vessels were deployed in May 1992, but the fleet declined to only 6 vessels by September of that year as the artisanal fishermen shifted to other ports and redirected their effort seasonally at alternative species (appendix A2c1). Given the activity from San Antonio, it is not surprising that much of Chile's swordfish catch is landed in San Antonio. Chilean swordfish fishermen normally land 45-70 percent of their catch in Region V ports. Landings in 1996 appear to have declined, but this is a statistical anomaly because the catch beyond 200-miles is not broken down by port (appendices E2e1-2).[703] While small amounts are landed at Valparaíso, the great bulk of the Region V swordfish catch is landed at San Antonio.

San Vicente: San Vicente is an artisanal port located a few km from Talcahuano in Region VIII (photos 1, 29, 40, 51, and 108). About 40 swordfish vessels were based in San Vicente during 1991 (appendix A2e). Landings can vary significantly from year to year. Some swordfish is also landed seasonally in San Vicente. Over 700 t, for example, was landed at the port during 1992. Landings since 1992, however, have declined sharply and in 1994-95 were only 60-70 t (appendix F4 and figure 102).

Santiago: Santiago is an inland city served by the ports of Valparaíso and San Antonio. While fish is thus not landed there, substantial quantities of swordfish is processed in the Santiago area. Nearly 2,000 t of raw material was processed in the Santiago metropolitan area during 1996 (appendix G2b9 and figure 119). (See "Processing and Products".) The processed product is then airshipped from Santiago's international airport.

Talcahuano: Talcahuano, located in Region VIII at about 37°S has become Chile's most important fishing port. The large ASMAR shipyard is located in

Photo 108.--Fishermen at San Vicente target demersal species during the spring/summer and swordfish during the fall/winter (March/June-July) Dennis Weidner

Talcahuano. The fishmeal industry developed later in Talcahuano, and adjacent ports like Coronel, than in Chile's northern ports.[704] The recent development of the jack mackerel fishery off the central coast has resulted in massive landings at Talcahuano which may currently handle more fish annually than any other port in the world. Fishermen during 1996 landed nearly 4 million t of fish in Region VIII (mostly the Talcahuano area), more than landed by most countries. The focus at Talcahuano is on fishmeal reduction and canning (photo 109). The swordfish fishery, however, also plays a small role. Very small numbers of swordfish vessels are based in Talcahuano (appendices A2d1-2 and figure 32), most of the fishermen appear to prefer Lebu and San Vicente. The ports in Region VIII (Coronel, Lebu, San Vicente, and Talcahuano) account for any where from 10-25 percent of Chilean swordfish landings for fishtaken within the 200-mile EEZ. Almost all of these landings are by the artisanal driftnet fishermen. Extremely large quantities of swordfish have been landed in Talcahuano, over 1,500 t in 1991, but this is unusual (appendix F4 and figure 102). Currently the Region VIII swordfish landings are relatively evenly divided among the ports in the area. Talcahuano is about 520 km south of Santiago and swordfish can be trucked to the Santiago airport in about 7 hours. Because of the large installed processing base in Talcahuano and nearby ports such as Tomé, some salmon farmers located to the south are processing their harvest in Talcahuano. As a result, a considerable quantity of fresh fish is regularly processed in the Talcahuano area and transported to the Santiago airport in large refrigerated trucks.

Photo 109 --Huge quantities of jack mackerel are landed at Talcahuano for reduction to fishmeal and canning. The swordfish landed there is a small part of the annual fisheries activity. D. Weidner

Valdivia: Valdivia is located at about 40°S in Region X. It is the southern-most port from which swordfish operations are normally conducted. Only a small number of swordfish vessels are usually based in the port. One report indicated six vessels were based there in 1991 (appendix A2e). Another report indicated as many as 26 vessels in 1992 (appendix A2c1 and figure 85). Very little swordfish is landed in Region X ports, almost all at Valdivia (appendices E2e1-2 and figures 100-101). Valdivia is located at the southern-most range of swordfish off Chile. Catches are extremely limited at this latitude. Valdivia is located at some distance from Santiago, about 840 kilometers. There is, however, very substantial quantities of fresh fish transported from the Valdivia and Puerto Montt areas to the Santiago airport--mostly salmon from the growing number of farms located in Region X.[705]

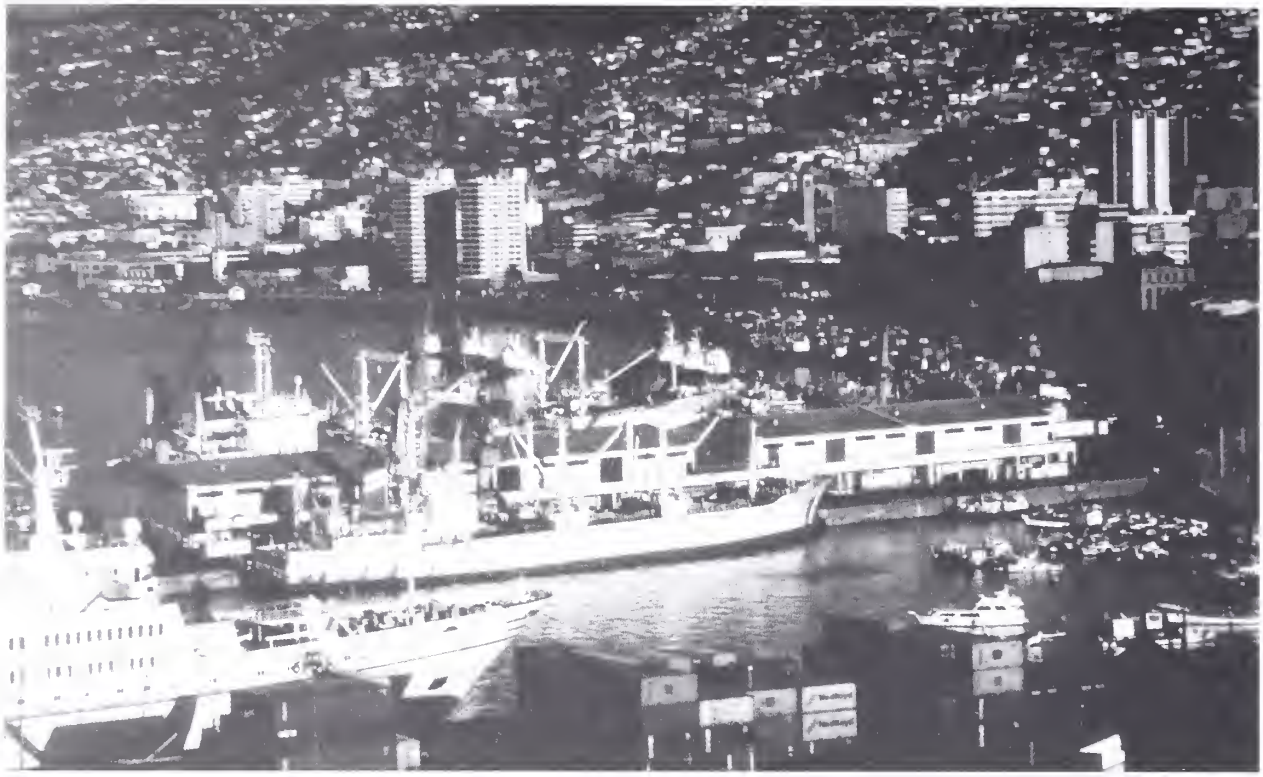

Photo 110 --Valparaíso is a large commercial port, but a small portion is set aside for artisanal and commercial fishermen. Dennis Weidner

Valparaíso: Valparaíso is located about 120 km west of Santiago and 115 km north of San Antonio in Region V. It is a large commercial port with shipyards and drydocks. It has traditionally been the principal port for Santiago, although considerable cargo traffic in recent years has shifted to San Antonio. Some swordfish fishermen use Valparaíso and a section of the port is set aside for mostly artisanal fishermen (photos 24 and 110). Sizeable fluctuations are reported from year to year. One report indicated that nearly 70 vessels targeting swordfish were based there in 1991 (appendix A2e), but another report suggested about 20-25 vessels during 1992-93 (appendix A2c1 and figure 85). A recent report indicated that nearly 60 vessels used the port in 1994, but only about 20 vessels in 1995 (appendices A2d1-2 and figure 32). While several vessels operate out of Valparaíso, a relatively small part of the swordfish catch is landed in Valparaíso (appendix F1 and figure 104).[706] Mostly artisanal driftnet vessels operated out of Valparaíso in 1995 and the quantities of fish landed were relatively small.[707] Most of the swordfish fishermen appear to prefer nearby San Antonio which is normally less congested.

The Chilean Government is preparing to significantly alter its port network which is currently administered through state-owned companies. The Chamber of Deputies in August 1996 unanimously passed a bill which will privatize a substantial portion of the Government's port operations. The senate has not, however, passed the bill and is still studying the proposal as of early 1997. The new legislation, when passed, will split the state-owned Empresa Portuaria de Chile (EMPORCHI) into nine independent private companies located at major ports. One of the primary purposes of the bill is to generate the investment capital needed to finance port infrastructure improvements.[708] The quantity of freight shipped through Chilean ports has grown rapidly in the past few years as the Chilean economy has expanded. Shipments in 1995 totaled about 38 million tons. Much of the freight is from the mining industry, but there are now major contributions from the country's growing agriculture, fisheries, and forestry sectors. Chilean ports also handle sizeable shipments from Brazil and Argentina. Government officials believe that shipments could reach 55 million t by 2000. The port privatization bill will encourage private investment through concessions lasting up to 30 years for the management and operation of docks. The Public Works Ministry estimates that investments totaling about $0.5 billion are needed in the next few years to improve and enlarge the country's ageing port facilities.[709] Swordfish fishermen, of course, are a minor group using the ports, but they, like other fishing industry sectors, would benefit from the planned improvements.

IX. Transshipments

A. Foreign fishermen

Chilean regulation permit some transshipping of fishery products by foreign fishermen. The Chilean "Ley General de Pesca y Acuicultura" (1991) provides the authority for regulating foreign fishing vessels desiring to transship their catch through Chilean ports.[710] The "Ley Arica-Parinacota" (1995) authorizes foreign fishing vessels to transship free of duty through Chilean ports if the vessels comply with Chilean fishery regulations and install satellite positioning equipment to verify where the catch was taken.[711] Two ports have been designated for transshipping: Arica in the far north and Punta Arenas in the far south. Chile allows foreign fishermen to transship a wide variety of species, as long as they are species which are not targeted by Chilean fishermen. Chilean authorities thus allow the foreign fishermen to transship tuna because it is not taken by domestic fishermen, but do not permit swordfish transshipments because the species is taken by the hard-pressed domestic fishermen who have faced steadily declining catches in recent years.

Photo 111--Excellent port facilities and regular traffic make Arica an ideal transhipment point. Spanish fishermen complain, however, that they cannot transship their swordfish catch. SERNAP

Activities at the two ports where transhipping is allowed include:

Arica: Marine species taken on the highseas in the Pacific by foreign fishermen can be landed in Arica. The excellent facilities and extensive availability of refrigerated cargo vessels make Arica a convenient transshipment point for foreign fishermen operating in the southeastern Pacific (photo 111). Most of the transshipped product in 1995 was squat lobster ("langostino") and tuna. Russian and Panamanian vessels during 1995 conducted 13 transshipments of squat lobster. Japanese, Honduran, and Panamanian vessels conducted 14 transshipments of tunas in 1995. Transshipments in 1996 included tuna by Japanese and Honduran vessels and squat lobster by Panamanian vessels.[712] The Panamanian and Honduran vessels are flag-of-convenience vessels. While the nationality of the owners is unknown, they are probably from Taiwan as local Chilean observers report that the crews of these vessels are Chinese. SERNAP port inspections of these vessels have found about 5-6 percent of the quantity in the hold is swordfish.[713] While the foreign vessels are not allowed to transship Pacific swordfish through Arica, many call at the port to purchase supplies after transhipping through the nearby Peruvian port of Ilo (photo 112).[714]

Punta Arenas: Marine species taken in international waters in the Atlantic and Antarctic can be

Photo 112--Transshipping through Peruvian ports, rather than central Chilean ports, poses some disadvantages to foreign fishermen, such as greater distances from fishing grounds. Echeandía Z.

transshipped through Punta Arenas. A wide variety of species are transshipped by several different countries. One 1983 report, for example described a U.K. trawler transshipping to a Dutch factory trawler.[715] Transshipments in 1995 included squid, krill, and southern blue whiting ("merluza de tres aletas"). Japanese, Korean, and Spanish vessels conducted 7 transshipments of squid. Japanese and Ukrainian vessels conducted 4 transshipments of krill. A Japanese vessel conducted one transshipment of southern blue whiting.[716] Transshipments in 1996 followed a similar pattern, including groundfish by Argentine and Russian vessels, crab by Japanese vessels, squid by Japanese and Ukrainian vessels, and krill by British and Japanese vessels.[717]

Foreign fishermen do not transship Pacific swordfish through Chile. Chile only allows foreign fishermen to transship species and stocks that domestic fishermen are not fully utilizing. Thus tunas can be transshipped because Chile does not have a significant tuna fishery (appendix K2 and figure 155). Pacific swordfish, however, can not be transshipped because Chile does have an important swordfish fishery in the Pacific. (Atlantic swordfish can be transshipped, although none was actually transshipped through Punta Areas during 1995 because the fishery is conducted far to the north off Uruguay and Brazil.) Foreign fishermen, especially the Spanish, have expressed an interest in transshipping swordfish through Arica. The Spanish Asociación Nacional de Armadores de Buques Congeladores de Altura (ANAPA) complained to Spanish officials in 1991 about Chilean prohibitions on transshipping.[718] U.S. fishermen have also complained. (See "International".) As a result of the Chilean restrictions, the foreign fishermen have had to use Peruvian ports.[719]

B. Chilean fishermen

Chilean swordfish fishermen operating in distant-water fisheries land most of their catch in Chile rather than transshipping it. The only transshipments through foreign ports is the limited activity in the south Atlantic through Montevideo Uruguay.

1. Pacific

Chilean fishermen since 1991 have operated extensively in international waters, but none of this catch in the Pacific is transshipped. Chilean companies in 1989 began to acquire commercial longliners which they deployed for swordfish. While the Chilean swordfish fishery has been primarily a coastal fishery conducted by artisanal fishermen, the commercial fishermen operated further off the coast and in some years have taken the bulk of the catch. The commercial fishery was particularly dominate in 1996 when artisanal catches fell sharply (appendix E2f and figure 64).

The first commercial operations beyond the country's 200-mile zone were reported in 1991.

Photo 113.--Chile has distant-water freezer vessels, but fishing is mostly off Chile, with the exception of limited Atlantic transshipments through Montevideo. Carvajal L.

Initially most of the longline catch was frozen (photo 113). (See "Fishing Grounds.") Freezing the catch gave the fishermen great mobility because they were no longer restricted to trips of only a couple weeks as required when handling fresh product. Even so, almost all of the landings by the commercial fishermen handling frozen product were at domestic ports. The commercial fishermen in 1991 caught 765 t or over 10 percent of the overall swordfish catch in international waters outside the zone. During the

early 1990s, the Chilean catch outside the zone has ranged from 270 t (1995) to 985 t (1993). The 1993 catch outside the zone was over 20 percent of the country's overall swordfish catch (appendix E2b and figure 14). The 1995 catch outside 200-miles declined to only about 270 t, reflecting the overall decline in the fishery. The fishery changed radically, however, in 1996. Commercial fishing largely replaced artisanal fishing and shifted to grounds outside the 200-mile coastal zone. The commercial catch outside the 200-mile zone was a record 2,300 t, almost triple the previous record (1993) and nearly 75 percent of the overall catch (appendix E2b and figure 14). Even though Chilean fishermen conduct these operations outside 200-miles in international waters, virtually all the catch is believed to be landed at the Chilean ports from which they operate. (See "Ports.") As the commercial longliners are now landing fresh product, they are restricted in how far off the coast they can operate. They need to return to port within about 15 days to ensure the quality of the catch. They have the option, however, of freezing the catch taken at the beginning of the trip to extend the length of the voyage and range somewhat.

2. Atlantic

The few Chilean fishermen operating in the Atlantic out of Montevideo are landing at least part of their catch in that Uruguayan port.[720] Few details on the operations of these vessels, however, are available.[721] (See "International.") The principal company involved in Atlantic operations is Pesquera Omega. (See "Organizations".) SERNAP officials confirm that Chilean fishermen were transshipping relatively small quantities of swordfish taken in the southern Atlantic. The Chilean companies are submitting data to SERNAP which is including it in the Chilean catch outside 200-miles (appendix E2b and figure 14). No precise breakdown of this data is available. The authors believe, however, the quantities being taken in the south atlantic are relatively limited. They may well reflect the "exports" to Uruguay reported by SSP, 50 t in 1995 and 169 t (153 t frozen and 16 t fresh) in 1996 (appendix J2f1).[722] SERNAP officials report that they are developing a satellite vessel monitoring system (VMS) to control this activity.[723] (See "Enforcement".)

X. Processing and Products

The Chilean fishing industry has centered on the production of fishmeal. The fishmeal reduction industry generally accounts for more than 90 percent of the entire Chilean fisheries catch (appendix G1a and figure 110). Much of the artisanal catch is landed whole and marketed without further processing domestically. The more valuable species as well as the catch of commercial fishermen is processed. Most of the catch to be processed for human consumption is either frozen or canned. Frozen fish production since the mid-1980s has increased steadily, primarily because of the extraordinary expansion of cultured salmon harvests (appendix G1b and figure 111). Canned productions continues to be important, but has declined somewhat in recent years. The production of high-quality fresh fish for export is a more recent development which began in the mid-1980s. Swordfish was one of the first species shipped fresh in quantity. Swordfish production in the late 1980s reached more than 20 percent of overall output of fresh product (appendix G1c and figure 112). Since the 1989, however, the swordfish proportion of fresh production has declined. This is partly due to declining swordfish catches after 1991, but more importantly to the rapid expansion of cultured salmon harvests--especially Atlantic salmon which is primarily marketed fresh.

Swordfish are minimally processed at sea. The fish are routinely gutted and headed and then stored as trunks which are about 70 percent of the animal's live weight (photo 114).[724] (See "Gear and Fleet Operations".) The handling of swordfish improved greatly in the mid-1980s as artisanal fishermen began targeting export markets and the use of larger vessels enabled the fishermen to store the fish in ice holds.[725] Companies with experience in producing high-quality export-grade product began deploying vessels in the late 1980s. Most of the artisanal and all of the commercial fishermen now deploy vessels with either insulated ice holds or freezers.[726] Fishermen land both fresh and frozen swordfish, however, the bulk of the catch is landed and exported as the more valuable fresh product (appendix J2b, figure 131, and photo 115). Upon landing the trunks are weighed and washed. The smaller trunks are usually exported immediately without further processing. They are placed in cardboard boxes with a plastic wrap, packed with dry ice or gell-packs, and then trucked directly to the airport in insulated trucks (photos 116-117).[727] Companies within only a few years developed refined procedures for handling the fish.

The production of fresh and frozen product has fluctuated since the current fishery was initiated in the mid-1980s.

1980-84: Chilean companies produced minimal amounts of swordfish during the early 1980s (appendix G3a and figure 113), reflecting the small catch.

1985-89: Chilean production statistics suggest that comparable quantities of fresh and frozen swordfish (raw material) was utilized during the early phase of the industry's development (appendix G2a and figure 114). This varies somewhat from available export data

Photo 114.--Swordfish are headed and gutted at sea and then stored as fresh or frozen trunks. Herman Caravajal Leon.

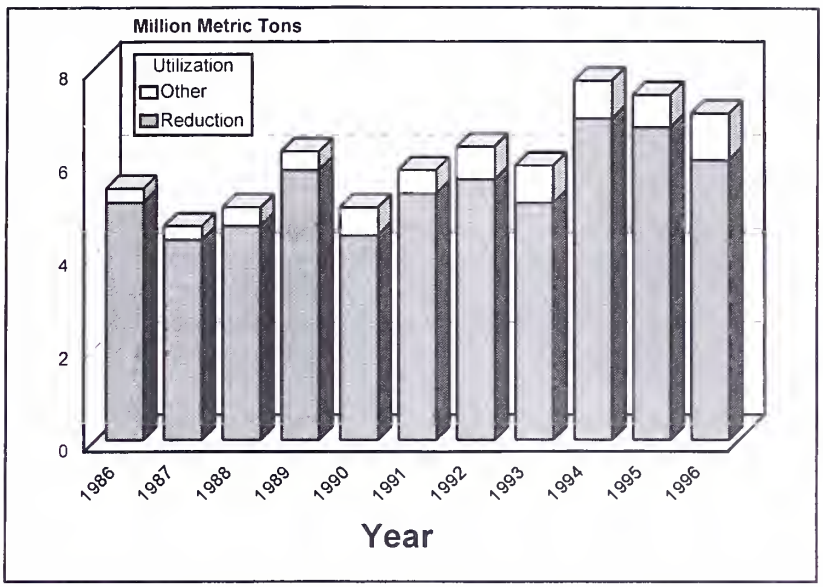

Figure 110.--The Chilean fisheries catch is still primarily used for reduction, but utilization for edible products is gradually increasing.

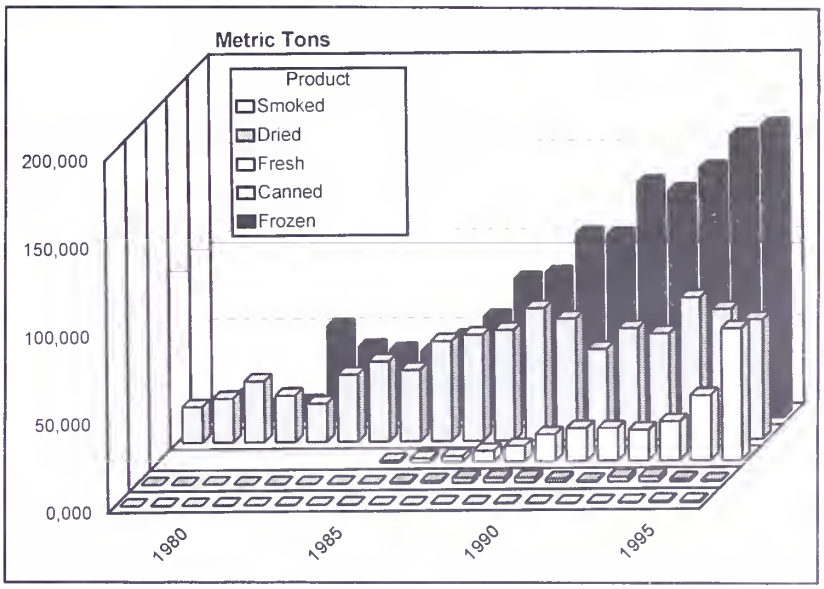

Figure 111.--Chile's major edible commodity form is frozen products, but production of fresh products are rapidly increasing.

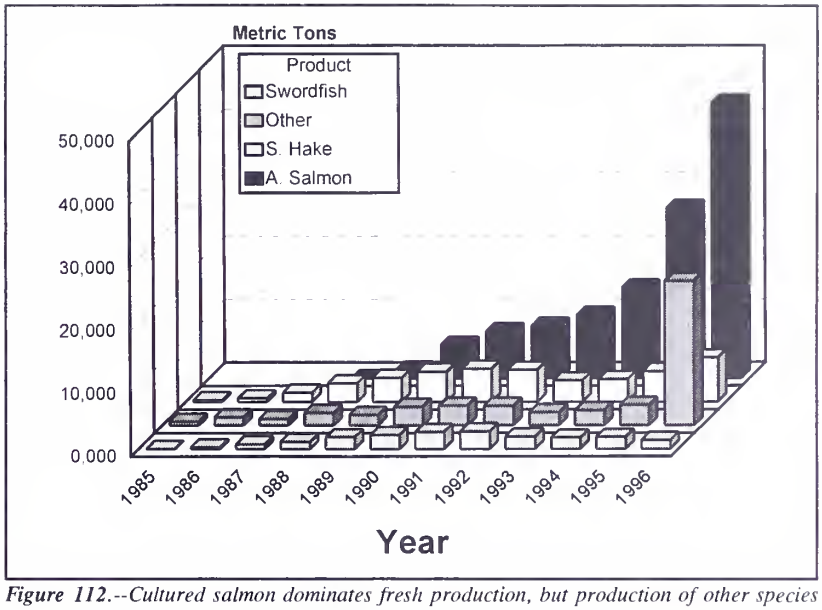

Figure 112.--Cultured salmon dominates fresh production, but production of other species expanded in 1996, partially explaining the shift of artisanal effort from swordfish.

Photo 115.--Virtually all of Chile's swordfish is now kept as fresh product in ice holds because of the higher prices available for fresh fish. Herman Caravajal Leon.

Photo 117.--Swordfish landed in the morning or afternoon can usually be at the Santiago International Airport for evening flights to Miami. Herman Caravajal Leon.

Photo 116.--Swordfish trunks are carefully wrapped in boxes and plastic wrap and kept chilled with dry ice. Herman Caravajal Leon.

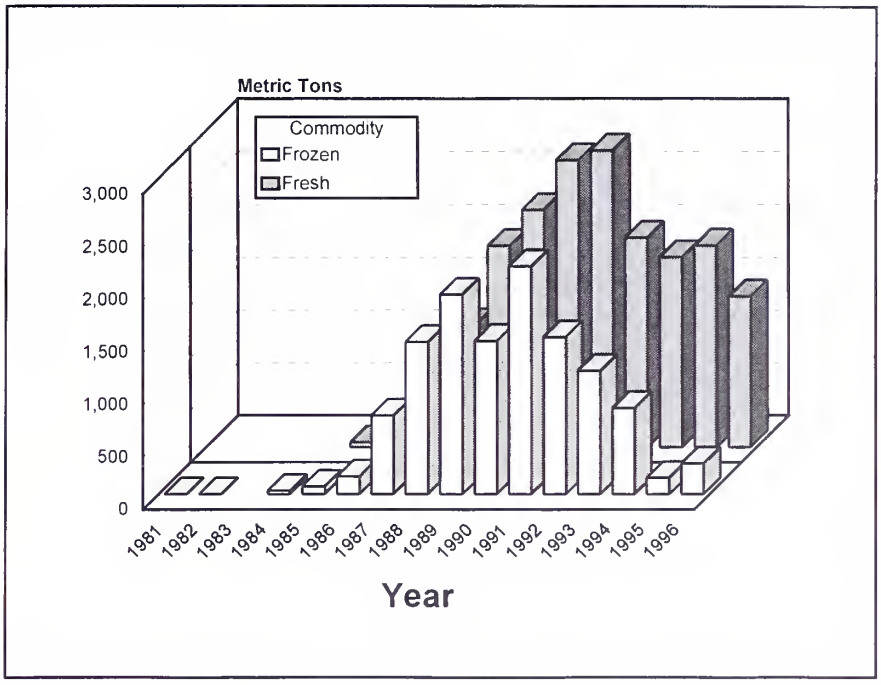

Figure 113.--Chilean companies initially produced both fresh and frozen swordfish products, but since 1995 almost all production has been fresh.

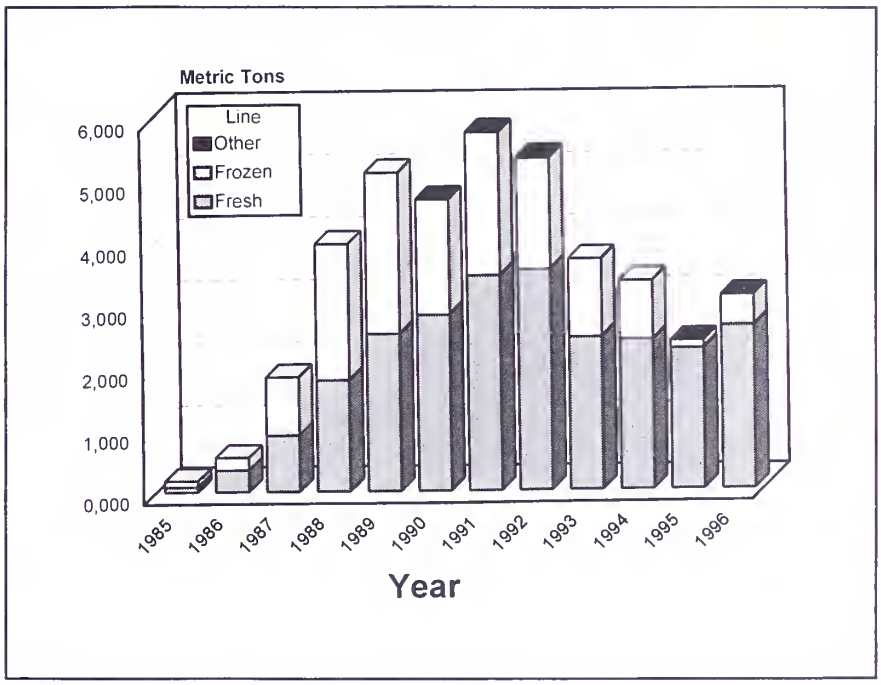

Figure 114.--The small increase in utilization of the catch for frozen products was due to the expanded commercial catch.

which suggests that most of the catch was marketed fresh (appendix J2b and figure 131). The authors can not explain this discrepancy. Some U.S. wholesalers complained of inadequate handling standards during this period. One importer indicated in 1988 that fish were "sitting around for 8 days or so under improper conditions before being shipped."[728] Some Chilean companies, however, addressed the quality issue and as early as 1988 had refined handling procedures so that fish were being shipped within 12 hours of landing.[729]

1990-93: Chilean companies gradually shifted to the production of fresh product, but frozen production remained important. Companies reported that fresh production shifted only slightly between 1990 (61 percent) and 1993-94 (66-68 percent) (appendix G2a and figure 114). One local observer maintained in 1992 that the growing importance of the commercial fleet was helping to improve the quality of Chilean shipments.[730]

1994-96: The production of frozen swordfish, along with overall output, fell sharply in both 1994 and 1995. Almost all of the frozen product is supplied by commercial fishermen. The 1994-95 decline in production of frozen product mirrors the decline in commercial operations during this period. Not only did overall commercial catches decline (appendix E2f and figure 64), but the companies involved increasingly shifted to fresh product. Chilean companies report that by 1995 almost all of the country's swordfish production (94 percent) was being marketed fresh (appendix G2a and figure 114).[731] Fresh product continued to dominate production in 1996, but there was an increase in frozen output. Fresh product still dominated the output, but declined somewhat in importance (88 percent). The 1996 increase in frozen output was due to the recovery of the commercial fishery. While commercial fishermen, like the artisanal fishermen, now focus largely on fresh product they produce some frozen swordfish--usually the catch taken during the first few days of operations. (See "Gear and Fleet Operations".)

Chilean companies export most of their swordfish output as a wide-variety of value-added processed products, unlike most other Latin American countries. The companies also ship a sizeable quantity of H&G trunks without further processing. The processed forms vary somewhat depending on whether fresh or frozen product is being prepared and on the size of the fish. Generally it is the larger fish that are processed into loins.[732] Usually trunks und100 kg are processed in to 8-15 kg chunks ("trozados") because this form provides the best yields for the smaller fish. The larger fish are used to produce loins ("lomos") which are a half of a chunk cut near the lateral line. The belly flaps which command a high price are cut out of the underside of the fish.[733] One observer, however, indicates that the profitability of processing these products has declined. In recent years companies have curtailed processing and are increasingly shipping unprocessed H&G trunks (photo 118).[734] This tendency is confirmed by Chilean export data.

Fresh: Most of the fresh product is loins or headed

Photo 118.--Chilean companies were processing mostly loins, but since 1993 have been shipping increasing quantities of H&G trunks. Seafood Leader.

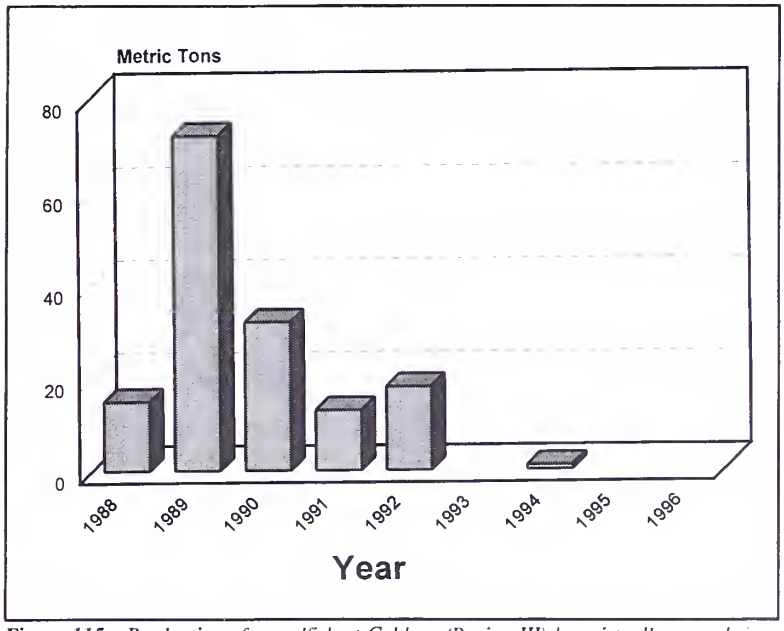

Figure 115.--Production of swordfish at Caldera (Region III) has virtually ceased since 1992.

and gutted trunks.

Loins: The single most important fresh product through 1994 was loins.[735] Over 40 percent of the fresh swordfish output/exports in 1994 was loins (appendix J2h2 and figure 147).[736] Chilean processors refer to the loins variously as "lonjas" and "lomos", but they are basically part of the fillets cut from each side of the fish. If the fish is very large, the fillet is too big to handle and loins are then cut from the fillet. The number of loins that can be obtained from a single fillet depends on the size of the fish.[737]

Portions: Portions ("trozados") are also important, in some years rivaling the quantity of loins. In recent years portions have varied from 16 (1996) to 33 (1993) percent of fresh output (appendix J2h2 and figure 147). The proportion of production appears to have fallen from 1993 levels and leveled off at 16-21 percent during 1994-96.

Trunks: Most of the remaining production is headed and gutted trunks. Most of the trunks retain the tails for ease of handling. Some are shipped, however, without the tails. Chilean companies have sharply increased the proportion of trunks shipped with out further processing, from 23 percent (1993) to 40 percent (1996). This is not just a function of the sharp shift to commercial fishing in 1996, because the proportion of trunks shipped without processing increased steadily in 1994 and 1995, years in which most of the catch was landed by the artisanal fishermen (appendices J2h1-2 and figure 147). This shift to trunks appears to reflect a fundamental shift in the economics of the processing industry. Chilean observers report that the primary reason for this shift is the increasing preference of U.S. importers for unprocessed trunks, primarily because it can be delivered in a fresher state than processed product. U.S. importers have concluded that shipping large trunks immediately on landing helps to ensure receipt of the highest quality product. Importers than arrange for the processing locally to meet the needs of the market. While the cost of processing the fish in the United States is higher, it appears to be more than compensated for by the improved quality achieved. Notably the price of labor has been increasing in Chile as part of the country's economic expansion in the 1990s, further reducing the advantage of processing the fish in Chile. U.S. importers are somewhat concerned about Chilean processing standards. Some Chilean exporters have reportedly shipped poor quality product and impaired the reputation of those companies with high processing standards.[738]

Frozen: Most of the frozen output through 1995 was processed product, primarily fillets, although in 1994 substantial quantities of loins ("lomos") were also produced (appendix J2h1 and figure 147). Some companies produced vacuumed packed fillets which one 1990 report indicated created some interest in

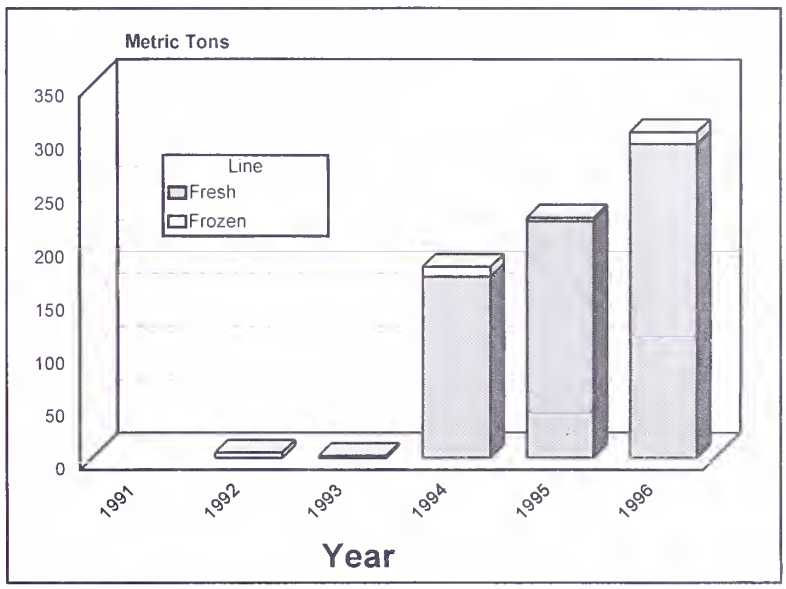

Figure 116.--Production of swordfish has become important at Coquimbo (Region IV) since 1994.

France.[739] Some belly flaps ("estomogos") are processed for the Korean and Japanese market where they are used for sashimi and sushi.[740] Companies sharply changed the product mix in 1995 when they began to ship H&G trunks. This tendency continued in 1996 when nearly 60 percent of frozen product was shipped as H&G trunks (appendix J2h2 and figure 154).

Cured: Chilean companies during various years have produced limited amounts of cured product (appendix G2a). One Chilean company, De Veer Berti Vincent Eckart, in 1995 is known to have cured some swordfish. No details are currently available on the processing line or precise product forms.

Canned: Swordfish is not normally canned in Chile. There are reports during the 1940s, however, of small quantities being canned--primarily for export.[741] A limited quantity of swordfish was also canned in 1990 (appendix G2a), but the authors have no details on the companies involved or descriptions of the packs.

Other: Chilean researchers have assessed the possible use of a variety of products which could utilize, at least in part, some of the waste from processing lines or fish that is not export quality.[742] Some of the products assessed have included ground swordfish flesh and paté.[743]

The processing of swordfish varies significantly among the different ports from which the fishery is conducted. The great bulk of the swordfish is processed in Region V (San Antonio) with lesser quantities processed in Region VIII (especially Talcahuano) and the Santiago area.[744] The following data represents the quantities of product processed in each region. The totals include fresh and frozen trunks even if they are not processed further.

Region I: Processing in Arica and Iquique is minimal. The small quantities landed there have been frozen, but no production has been reported since 1994 (appendix G2b1).

Region II: Very small quantities of swordfish are processed in Antofagasta. The limited landings are all frozen, but no product has been processed since 1994 (appendix G2b2).

Region III: Small amounts of swordfish have been processed in Caldera, as much as 72 t in 1989. It is all processed as frozen product. No appreciable quantities have been processed since 1992 (appendix G2b3 and figure 115).

Region IV: The swordfish fleet was not active in Coquimbo during the early phase of the fishery. Production was not reported until 1992. Substantial quantities of fresh product were processed there beginning in 1994. Production has since steadily increased as the commercial fleet makes greater use of the port (photo 119). The raw material used for fresh product totaled 170 t (1994), 223 t (1995), and 295 t (1996). Small quantities of frozen product are also processed at Coquimbo (appendix G2b4 and figure 116). The processing data gives a more accurate view of the port's importance than the landings data which does not include the catch taken beyond the 200-mile EEZ. In the case of Coquimbo, the quantity landed from operations the fishermen reported beyond 200-miles was very substantial in 1996.

Region V: Much of Chile's swordfish is processed in Region V ports, primarily San Antonio, where most of the catch taken within 200 miles is normally landed (appendix E2e1 and figure 66). Production in the early phase of the fishery (1987-89) was mostly frozen. The relative proportion of fresh and frozen product varied during the early 1990s, but in 1994-95 the proportion of frozen product dropped sharply. The raw material utilized in 1995 was about 750 t, mostly fresh product (over 90 percent) (appendix G2b5 and figure 117). Production declined somewhat in 1996, despite the catch increase.

Photo 119.--The commercial longline fleet has been making increasing use of the port of Coquimbo in recent years. Dennis Weidner.

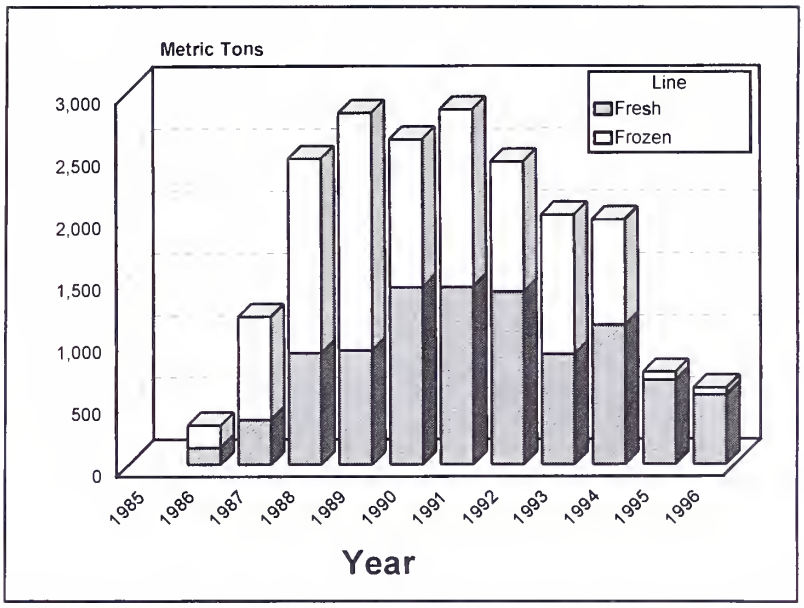

Figure 117.--Swordfish production at ports in Region V, especially San Antonio, has been important since the inception of that fishery.

Region VI: No swordfish is landed or processed in Region VI.

Region VII: Swordfish is not normally processed in Constitución. The only know processing occurred in 1988 and 1993 (appendix G2b6).

Region VIII: Some swordfish is processed at the several ports around Talcahuano in Region VIII. Nearly 500 t of raw material was utilized in 1992 and primarily frozen. Beginning in 1993 the production of frozen commodities declined and almost all of the swordfish is now fresh product. Processing in Region VIII, however, has gradually declined as Chile's catch has fallen. Only about 190 t was processed in 1996. The frozen output increased sharply in 1996, but production was still mostly fresh. (appendix G2b7 and figure 118).

Region IX: No swordfish is landed or processed in Region IX.

Region X: Very small amounts of swordfish is processed in Region IX and most of that is processed at Valdivia plants. The small quantities of raw material landed there during 1991-95 has been usually used for fresh product. An usually large amount (over 60 t) was landed in 1996 and mostly frozen (appendix G2b8).

Santiago area: Sizeable quantities of swordfish are trucked to the Santiago metropolitan area where they are processed. As much as 2,600 t of raw material was processed there in the peak 1991 year. Most of the output, especially since 1992, has been fresh product. This pattern continued in 1996 when over 1,600 t of raw material was processed. About 85 percent was processed as fresh product, but the quantity frozen increased substantially over 1995 levels (appendix G2b9 and figure 119).

Chilean swordfish processing shows a markedly seasonal trend.

Production: Since 1990, at least some swordfish production has been reported throughout the year. The production, as can be expected, follows the seasonal pattern of the catches. Significant production is generally first reported in March and then increases sharply in April. The largest output is generally reported in May. Production is usually good through July and sometimes August, but the output generally trails off to small amounts by September and especially October, following the seasonal pattern of the fishery (appendices G2c and G3c and figures 120-122). The expansion of the commercial fishery beyond the 200-mile EEZ in 1996 appears to be reducing somewhat the seasonality of fresh production (figure 122).

Prices: Prices earned by Chilean companies have fluctuated substantially in recent years. a full assessment of price trends would require detailed price data by product form. Such data is not available to the authors. A rough outline of trends is possible,

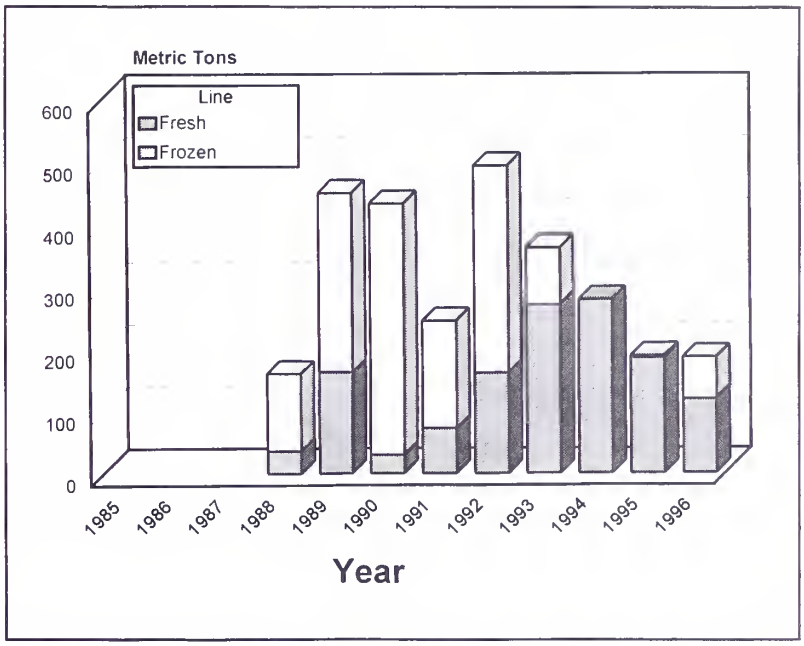

Figure 118.--Swordfish production and the product mix in the Talcahuano area (Region VIII) has varied substantially.

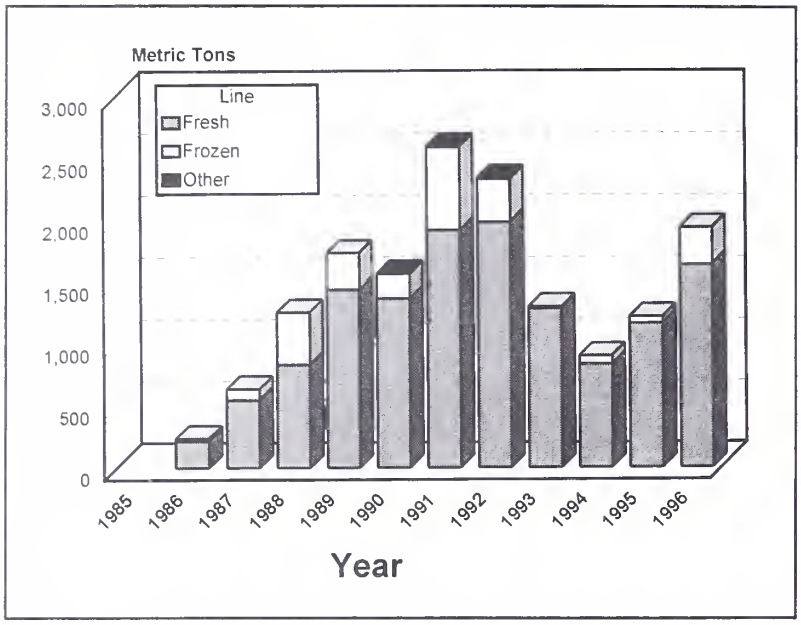

Figure 119.--Substantial quantities of swordfish, mostly fresh product, are processed in the Santiago area.

however, with some annual data derived from gross prices for fresh and frozen exports (appendix G4a).

Monthly: Chilean sources report that the highest prices are available during the first few months of the fishery and then decline during the months of peak landings. Prices reportedly begin to increase again as landings decline. The authors have been unable, however, to assess monthly price fluctuations due to time constraints. The limited available monthly price data does not seem to follow the pattern described above (appendix G4b). Price fluctuations in Chile, however, are not just a reflection of Chilean catch patterns. As most of the catch is exported, prices are largely determined by fluctuations in the United States, the principal U.S. market. This is especially true as Chilean catches have declined since 1991 and now have a smaller impact on the market.

Annual: Chilean companies have reported several major market shifts since the mid-1980s when the current fishery began landing substantial quantities. The fluctuations described below are estimated nominal prices based on Chilean export data (appendix G4a and figure 94). Available U.S. import data basically confirms the pattern described below, but there are some differences (appendix J3a1).[745]

1986-88: As artisanal fishermen began producing substantial quantities they were encouraged by rising prices for fresh product which reached $6.95/kg in 1987. The price in 1988 was little changed (appendix G4a).

1989-90: Prices for fresh product declined to only $5.47/kg in 1990. This may have been due, at least in part, to rapidly increasing Chilean catches which were beginning to have an important impact on the U.S. market. Frozen product sold for about $0.70 less (appendix G4a).

1991-94: Prices for fresh product increased to nearly $6.80/kg in 1991, despite a substantial increase in the Chilean catch. The price increase again in 1992 as the Chilean catch began to decline. Fresh prices during 1992-94 remained relatively constant at about $7.50-7.90/kg (appendix G4a). The difference between fresh and frozen prices, however, widened during this period, exceeding $1.50/kg in 1994 (appendix G2a and figure 123). The absolute price for frozen product was little changed from 1989 levels. Many companies found it unprofitable to process frozen swordfish, explaining the steady decline in frozen production during this period (appendix G3a and figure 113). The impact on the companies which had made sizeable investment in freezer vessels was notable.

1995-96: Fresh prices increased again to $8.60-8.80/kg during 1995-96. The rising prices for fresh product and weak prices for frozen product resulted in the almost complete conversion of the commercial

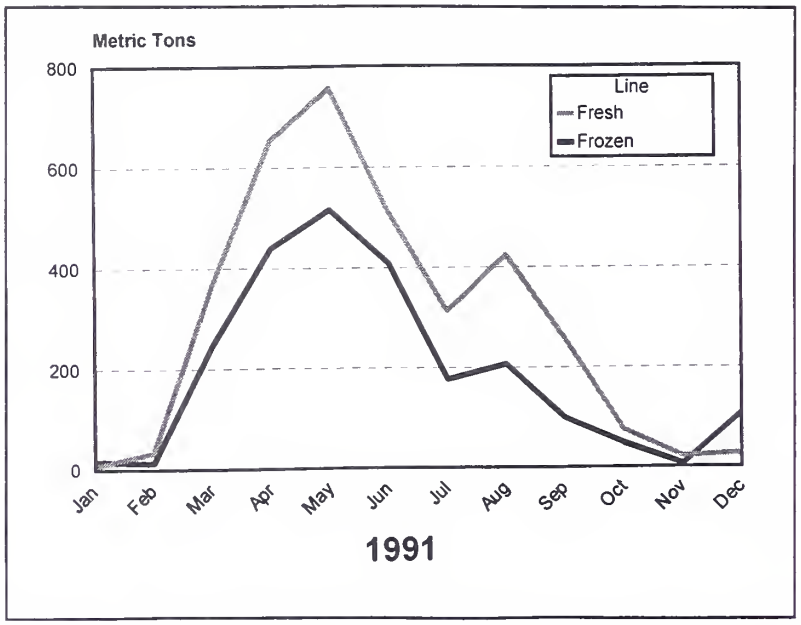

Figure 120.--The seasonal pattern of swordfish production showed activity from March through September in 1991 at the peak of the fishery.

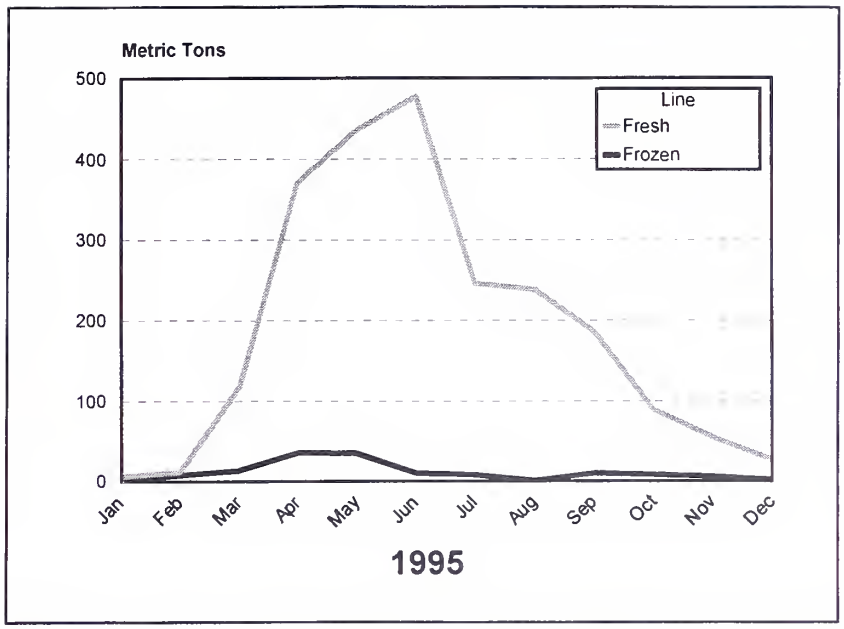

Figure 121.--The seasonal pattern of fresh production decreased slightly in 1995, although little product was frozen.

fishery to fresh product. The difference between fresh and frozen prices reached over $3.00/kg in 1996 (appendix G4a and figure 123). Much of the frozen product landed is the catch during the first few days of an extended trip.

The authors have noted scattered reports concerning Chilean swordfish quality.

Pacific fish: One Chilean company, Pesquera Omega, deploying longliners in both the Pacific and Atlantic, claims that Pacific-caught fish are generally of higher quality. He indicated that the Pacific fish tend to have much lower mercury levels than the Atlantic fish. The company reports that they test their fish frequently and even the larger fish tend to have relatively low mercury levels. There is also no significant parasite problem with Chilean Pacific swordfish, the meat is firmer, and the color more appealing.[746]

Artisanal fish: Another company, Importadora y Exportadora Nanaimo, claims that they have found the artisanal fishermen produce the best quality fish. The executive interviewed said that he believes the difference is that the artisanal fishermen generally conduct shorter trips, currently averaging only about 8 days. This means that their catch is fresher than that of the commercial longliners which report 15-18/20 day trips (appendix D1).[747] The commercial fishermen currently freeze the fish they take on the first few days of an extended trip. Actual trip lengths vary by company and are affected by a variety of factors.

Fishermen report problems with fish damaged by sharks. Some fishermen report that up to 10 percent of the catch is damaged. About 5 percent is totally destroyed with just the head remaining on the hook. Another 5 percent has bites which mean the trunk can not be exported (photo 120). In some cases it can still be used to make loins or portions or can be sold on the domestic market.[748]

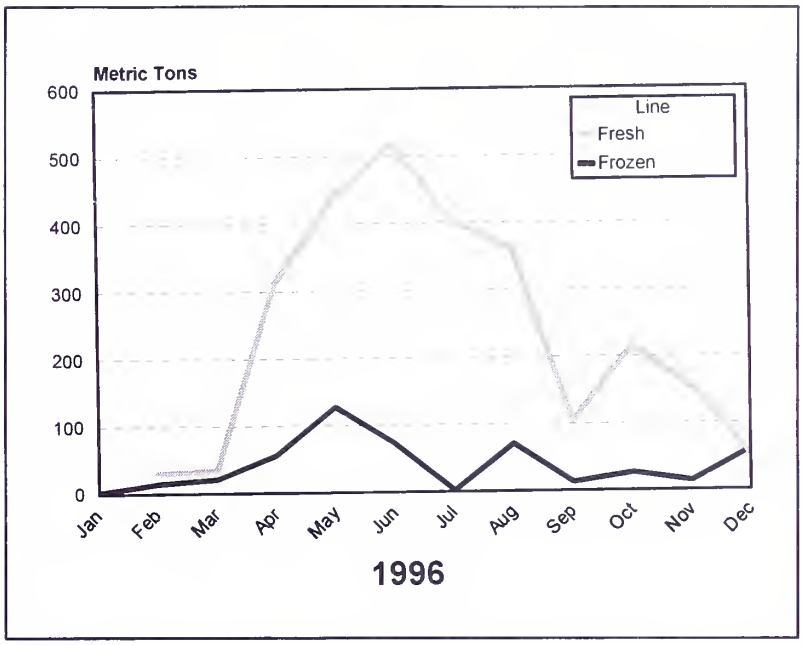

Figure 122.--The shift of the fishery from artisanal to commercial fishing resulted in increasing production during the last months of the year.

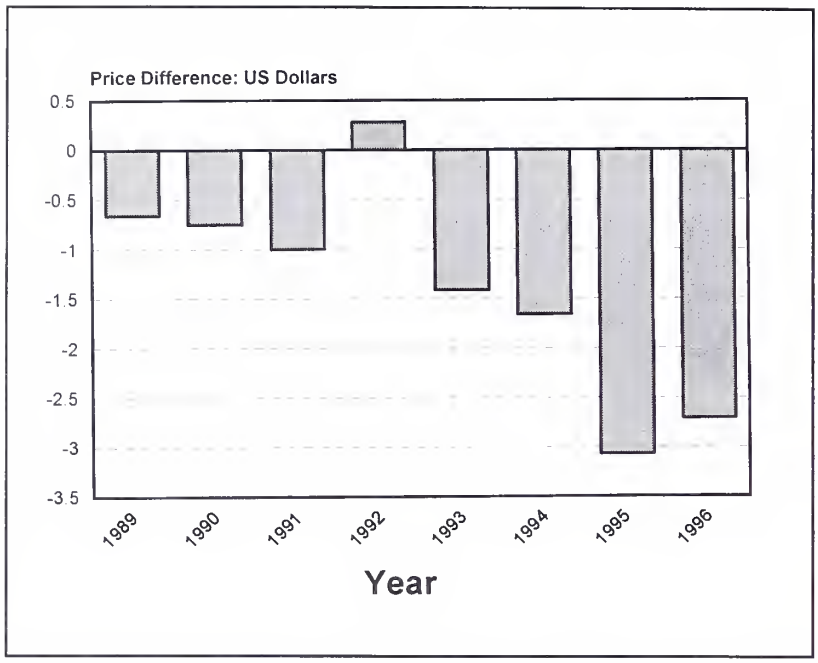

Figure 123.--A disparity exists between prices for fresh and frozen products, the major factor in the shift of commercial fisheries to frozen product.

Photo 120.--Sharks and other fish damage up to 10 percent of the Chilean catch, although sometimes the shark damage is minor. Herman Caravajal Leon.

XI. Organizations

The swordfish fishery is primarily conducted by individual artisanal fishermen or companies. A few trade associations, cooperatives, and unions also have small roles.

A. Companies

More than 40 Chilean companies participated in the swordfish industry during 1995. The number appears to have declined somewhat in 1996, but no precise list is available. Artisanal fishing is conducted mostly by individual fishermen. Only a few companies are involved in actual fishing operations which are primarily undertaken by the independent artisanal fishermen. A small number of companies have acquired longliners and conduct commercial fishing operations. Most of the remaining companies are seafood processors or specialized exporters. The major fishing, processing, and exporting companies have varied significantly from year to year. Companies have had to adjust to fluctuations in the catch, fishery (artisanal/commercial), and product forms (fresh/frozen). Some have successfully adjusted, other have not and have, as a result, closed or refocused their operations.

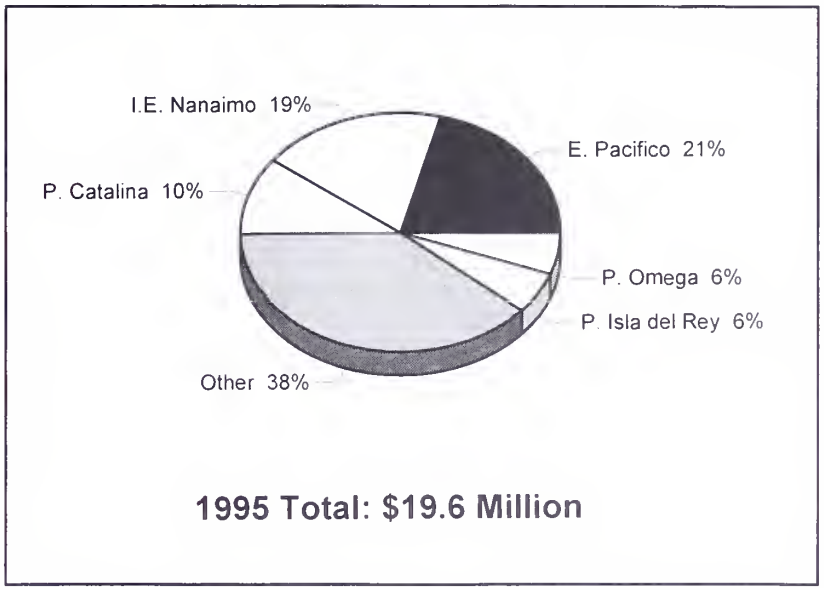

Figure 124.--Most of Chile's fresh exports were produced by five companies in 1995.

Fishing: The importance of Chilean companies in the fishery have varied. Chilean companies reported rapidly declining production after 1991 and by 1995 accounted for only a small portion of the swordfish catch. Artisanal fishermen who own their own vessels, primarily deploy multi-purpose vessels using driftnets, which have generally accounted for most of the catch. Several companies initially operated their own fleets (such as New Bay Products), but as a result of problems encountered after 1991 withdrew from fleet operations to focus primarily on processing. The few companies still operating company-owned driftnet vessels (such as Pesquera Grimar) are processing companies, many specializing in the production of fresh product.[749] Another company (Sociedad Reyes del Mar) operates vessels, but does not process the catch. Other companies operate a variety of vessels and gear, but most of the commercial catch is taken by longliners which initially focused on frozen product. Several companies were unable to adjust to the adverse market conditions for frozen product which is what they initially produced. (See "Processing and Products".) The longlining is now conducted by only a few companies (Pesquera Calcurrupe, Empresa del Estrecho, Pesquera Montemar, Pesquera Omega, and Pesquera Santa Lucía). All of which have refocussed their operations to fresh product (appendices A3b and e). The companies that remained in the fishery reported spectacular results in 1996 and the commercial catch increased 400 percent to 2,500 t (appendix E2f and figure 64).

Processing: Most of the companies now handling swordfish are processing companies. Almost all of the companies reporting important export shipments are primarily seafood processing companies.

Fresh: Fresh production is divided among several important producers, with the largest two (Empacadora del Pacífico and Importadora y Exportadora Nanaimo) accounting for about 37-45 percent of fresh shipments during 1995-96 (appendices H1a-b and H2 and figures 124-125). The major exporters can changed dramatically from year to year. One company (Pesquera Catalina) was important in 1995, but because it relies on artisanal fishermen for raw material, processed very little swordfish in 1996. Two unidentified companies were also important. Several companies (Pesquera Isla del Rey, Pesquera Omega, Atunmar, and Pesquera Santo Domingo) processed lesser amounts.

Frozen: Frozen production, while of relatively limited importance in recent years, was dominated by one of

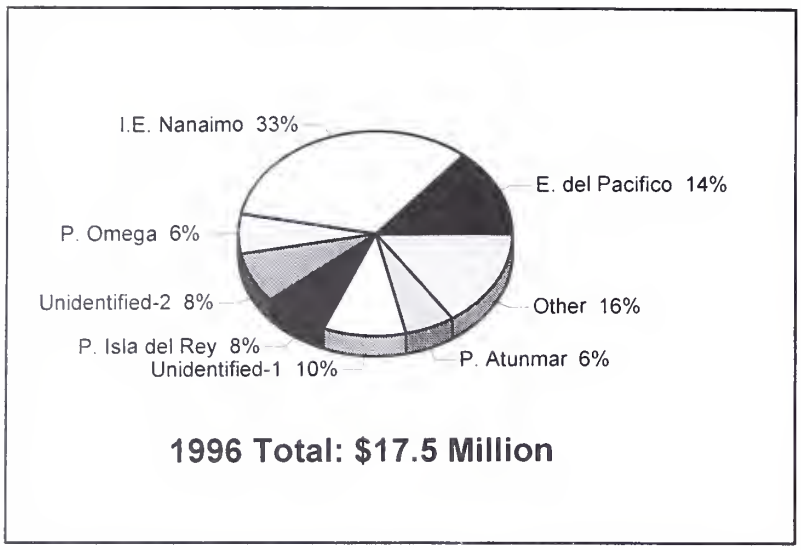

Figure 125.--Nanaimo emerged as the major exporter in 1996. Several companies working with artisanal fishermen reported sharply lower shipments.

two companies (Pesquera Marazul in 1994 and Pesquera Omega in 1995-96). Two companies (Pesquera Grimar and Empacadora Montemar) reported very large declines in 1995. Pesquera Marazul which had been the leading company (over 80 percent) in 1994 did not even handle swordfish in 1996 (appendices H1a-b and H2 and figure 126). Frozen exports during 1996 were processed by a larger number of companies (Pesquera Omega and Empacadora del Pacífico).

Other: Only one company (De Veer Berti Vincent Eckart) is known to have produced cured products.

Exporting: The authors do not have details on the number of specialized exporters handling swordfish. Exporters in 1994-95 totaled: fresh product (about 40 companies) and frozen product (about 12 companies). A cursory examination of the list of exporters suggest that as much as half of the companies involved are specialized exporters which do not process seafood (such as Andes Sur and BCA Comercial) (appendix H2). Instead they contracted processing companies (such as Pesquera Santo Domingo) to pack the fish. Most of these exporters, however, handle relatively small quantities of swordfish. Many of the important exporters were also processing companies. The leading 1996 exporters were I.E., Empacadora del Pacífico Nanaimo, and an unidentified company (fresh product) and Pesquera Omega, Empacadora del Pacífico, Andes Sur, and BCA Comercial (frozen product) (appendix H1b and figures 124-126).

The commercial sector of Chile's fishing industry is composed of companies with a great range of managerial and technical capabilities and experiences. The overall fishing industry has been dominated by a small number of large companies focusing primarily on the reduction of small pelagic species to fishmeal and oil. All of these large companies primarily target export markets. Several of these companies also operate canneries, but in recent years have further diversified to include high-quality frozen products. Several of these processing companies operate company fleets. All of Chile's commercial longline fleet, for example, is operated by companies (appendices A3b and e). The industry also includes several small companies which specialize in high-quality fresh product or other specialized processing such as curing.[750] Most of these companies do not operate vessels, but instead purchase their raw material from artisanal fishermen. Many have developed close ties with individual artisanal fishermen and work closely with them on handling and storage practices to help ensure product quality.[751] One company (EMPAC) reports associations with 60 artisanal fishermen. Another (Pesquera Catalina) works with about 35 artisanal fishermen. The companies involved with swordfish have been primarily smaller Chilean companies. The expanding salmon culture industry has caught the attention of several of the larger Chilean companies which have significantly expanded production of fresh fish in recent years, especially since 1993 (appendix G1c and figure 112).[752] The smaller size of the swordfish fishery, especially at current levels, has generally meant that the large companies have not focused extensively on it.

Companies report significant annual fluctuations as to which companies process the larger quantities of swordfish products. The authors have noted sharp annual shifts in the primary companies participating in the swordfish fishery and processing industry. The leading companies have varied substantially from year to year (appendices H1-2 and figures 124-126). The decline of the swordfish catch has caused considerable difficulty for several companies. Many companies have redeployed fishing vessels and/or processing lines for other species. A few companies were very dependent on swordfish and have been affected more than other. Several companies have had to close, although in a few cases adverse developments in other fisheries were also involved in the closure.

Available information on the individual Chilean companies involved in the swordfish industry are as follows:

Agropesca: This Arica-based company in the extreme north of Chile processes frozen swordfish.

Alimentos Multiexport: This Santiago-based company has a processing plants in Puerto Montt. The company focuses primarily on cultured salmon. It began processing and exporting small quantities of fresh and frozen swordfish in 1991. Much of the raw material was supplied by Pesquera Omega's longliners.[753]

Arrirang Chile: This company, presumably with Korean ties, exports small quantities of frozen swordfish (appendix H1a).

Azócar: Some Chilean sources refer to "Azócar" as a company. This is probably a reference to Pesquera Santo Domingo which is owned by Jaime Azócar.

Andes Sur: Andes Sur was established in 1985. The company is an exporter without any processing facilities of its own. Andes Sur handles both fresh and frozen fish, including small quantities of swordfish. Shipments of frozen product total about 20 t annually (appendix H1a). The swordfish products currently exported include frozen and fresh loins and frozen fillets. The principal export market is Switzerland where they sell primarily to a supermarket chain (appendix H3).[754]

Atunmar: See Pesquera Atunmar.

BCA Commercial: This San Antonio company produces small quantities of frozen swordfish which it primarily markets in Japan (appendices H1-2 and figure 126). Shipments total 15-30 t of frozen product annually.

Cabo Azul: The former manager of Marazul plans to open a fishing company, Cabo Azul. He has already opened a new fish exporting company, Terramar.

Chisal: This company exports small quantities of frozen swordfish (appendix H1a).

CITI TRADE: This subsidiary of the U.S. City Corp. was an important exporter of swordfish during the late 1980s.[755]

Comercial Ocean Star: This company exports small quantities of fresh swordfish. Shipments in 1996 totaled over 60 t, a substantial decline from the nearly 100 t shipped in 1995 (appendix H1a).

Comercializadora y Elabadora de Productos del Mar y Hortofruitcolas y Presentación de Servicios: This company processes fresh and frozen swordfish.

Commercial Cisandina: This Santiago-based company was established in 1983. The company worked hard on perfecting its handling procedures and in 1988 reporting shipping swordfish within 12 hours of landing.[756] It obtains product from the fishermen as well as processing companies. It has no processing facilities of its own and outsources processing as required. The company reports shipping about 100 t of H&G trunks and fillets annually.[757] Available data, however, suggests somewhat smaller shipments (appendix H2). Cisandina also operates salmon farms in southern Chile and the main export commodity is fresh salmon. Other species handled besides swordfish include various groundfish, including hake, toothfish, congrio/kingklip, as well as seabass, crabs, Chilean abalone, and scallops, among other shellfish. The company's largest two export market are Japan and the United States, in that order. The United States, however, is the company's largest export market for swordfish.[758]

Commercial Mar Andino: This company processes fresh and frozen swordfish.

Compañía Conservera Cavancha: This Iquique cannery experimented with a harpoon "rifle" during the 1950s.[759]

De Veer Berti Vincent Eckart: This company in 1995 was the only company known to have produced cured swordfish products (appendices H1a-b and H2). Production is mostly marketed domestically, but there are also some sales to Bolivia.

Elab. y Comer. de Alimentos: This company exported small quantities of frozen swordfish in 1995 (appendix H1a).

Empacadora Montemar: Montemar had a processing plant in San Antonio and was headquartered in Santiago. The associated fishing company, Pesquera Montemar, deployed the 27-m longliner *Kofuku Maru 58* for fresh swordfish (appendices A3b and e). The name of the vessel suggested that there was some Japanese involvement in the company. Montemar processed both fresh and frozen fish. It was a major producer of fresh swordfish in 1994, although output declined in 1995 (appendix H1-2). It has been one of the principal Chilean swordfish exporters, handling its own product as well as that of Pesquera Santo Domingo and other companies, but ceased operations in 1995. It was owned by the Ventura Sánchez Group which still operates Importadora y Exportadora Nanaimo, another Chilean seafood company which exports swordfish.

Empacadora del Pacífico (EMPAC): EMPAC is a processing and export company established in 1982. The company has been one of the leading processors since the current fishery began in the mid-1980s. EMPAC handles a wide range of seafood and began to process swordfish from the beginning of the current fishery in 1985-86. By 1988 the company was handling about 500 t of swordfish per season. At the time, no one was sure of the potential for harvesting swordfish in Chile. EMPAC representatives were optimistic that the fishery could be significantly expanded, telling one reporter, "The Pacific is a big ocean," and adding that the fish were averaging about 135 kilograms.[760] EMPAC continues to be a major supplier. It was one of the leading producers of fresh swordfish in 1994, the most important producer during 1995, and the second leading producer in 1996

(appendices H1a-b and H2 and figures 124-125). It directly employs 40 persons and provides indirect employment to 150. The company in 1995 worked with 60 independently owned vessels, mostly driftnet vessels but also 6 longliners. The vessels primarily deploy driftnets, but there are also six longliners. Fishermen report a shark by-catch, mostly mako ("marrajos") and blues ("azulejos."). EMPAC has a fleet of refrigerated trucks to pick up the catch directly at the port. Trips to the processing plant can take 1.5-8.0 hours (110-850 km), depending on the port where the fish is landed. The company handled 480 t of fresh swordfish in 1995, but only about 390 t in 1996. It also handles smaller quantities of frozen product (appendix H1b). EMPAC also deals in albacore tuna and Patagonian toothfish ("bacalao de profundidad" or "mero").[761] The principal product forms produced are fresh H&G, loins, and fillets which account for 90 percent of the swordfish production. Smaller quantities of frozen fillets and steaks are also produced. The principal market is the United States. The company has the capacity of processing about 13-16 t of fresh product and 50-60 t of frozen product daily. A fleet of refrigerated trucks delivers fish to the company's processing plant in from 1.5-10.0 hours, depending on the port.[762]

Exportadora Montemar: This new company began operations in 1996. It is not associated with either Empacadora Montemar or Pesquera Montemar. They buy swordfish from both artisanal and commercial fishermen and then contract for the processing, often with Pesquera Santo Domingo. Montemar handles the export shipping and marketing.

Importadora y Exportadora Nanaimo: This company is a major producer of fresh product, reporting the second highest shipments in 1995 and the highest in 1996 (appendices H1a-b and H2 and figures 124-125). Nanaimo exported about one-third of all fresh shipments during 1996, a record 612 t of fresh swordfish. It has been conducting swordfish processing and exporting operations since 1980. The company obtains the swordfish from many different artisanal fishermen. The average vessel utilized by the associated artisanal fishermen is 18-meter long. The fishermen primarily use driftnets. Harpoons are occasionally utilized, mainly during the beginning of the season (January through early March). Almost all of the catch is taken with driftnets, especially during the main season (March through August). Nanaimo representatives indicate in 1995 that the company does not purchase swordfish from large longliners because they believe the quality of the fish is inferior to that of the fish landed by the artisanal fishermen. The difference in quality is due mainly to the relatively short artisanal trips which allow them to land much fresher fish.[763] Given the decline of the artisanal fishery in 1996, Nanaimo may have had to reassess their policies. The company processes approximately 400-600 t of swordfish per year, of which 80 percent is exported as fresh loins and 20 percent as fresh H&G. Most of the swordfish is exported to the United States, primarily through Miami, but some product is also shipped to other cities (Atlanta, Boston, New York, Seattle, Dallas, Pittsburgh, and San Francisco). The company also exports small amounts to Canada and Europe.[764]

Isla del Rey: See Pesquera Isla del Rey.

Mendoza Hozman: This company processes fresh and frozen swordfish.

Muñoz Concha: Heriberto Muñoz Concha owns and manages his own fish processing venture in Valdivia. He opened the plant in 1986, but has only been processing swordfish since 1992. He buys fresh product from artisanal fishermen operating from Lebu, Constitución, San Vicente, and Valdivia. He usually processes swordfish seasonally, mostly from March through June. Almost all of his output is fresh loins which he then sells to exporters such as Exportadora Montemar, New Bay Products, Pesquera Grimar, and Pesquera Isla del Rey. All of these exporters mostly target the U.S. market. Sr. Concha is particularly concerned about the declining catches and reduced availability of raw material. He claims that foreign longliners operating beyond Chile's 200-mile limit are the primary cause of the decline.[765]

Nanaimo: See Importadora y Exportadora Nanaimo.

New Bay Products: This Santiago-based company has been one of the principal Chilean swordfish exporters and handles a variety of other species. New Bay once operated its own artisanal vessels, but has since sold them and withdrawn from

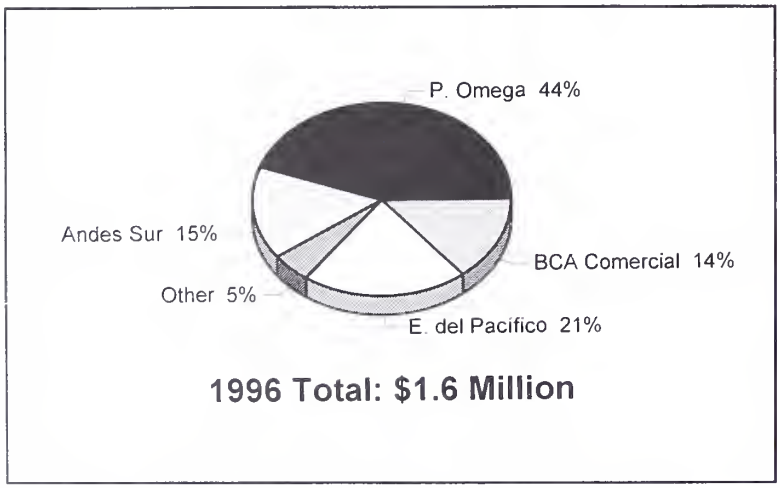

Figure 126.--Pesqueras Omega is the major exporter of frozen swordfish.

actual fishing operations. Instead, it purchases the catch of the artisanal fishermen and contracts with specialized processing companies like Pesquera Santo Domingo to process the fish. Company officials indicate that New Bay is one of the major Chilean swordfish exporters, shipping about 3 t of swordfish per week or 150 t annually. New Bay also handles Patagonian toothfish, jacks, sharks, and other species.[766] The company does not, however, appear on available lists of Chilean swordfish exporters (appendices H1a-b and H2).

Ocean Resources: This company handled swordfish during the 1980s. Company representatives were an early proponent of more stringent government regulations to protect the resource.[767]

Omega Seafoods: This Coquimbo-based company reported exports of frozen swordfish in 1995, mostly frozen product to the United States. Shipments totaled 38 t (appendices H1-2). They are the processing exporting arm of Pesquera Omega and operated by the same owners. (See Pesquera Omega below.) Much of the swordfish shipped by Omega Seafoods is processed product.[768] The authors believe that the two divisions are operated as separate entities for tax purposes. Both companies, however, report export shipments. Notably the company ceased swordfish export operations in 1996 (appendix H1a).

(Mario) Orellana Palma: This private fishermen purchased the swordfish vessel *Claevelkaren* from Sergio Toro Soto on February 19, 1997.[769]

Pesca Chile: This company is an affiliate of the large Spanish fishing company, Pescanova. It operates three trawlers and three longliners. Two additional longliners (*Pesca Chile* and *Lerez*) were recently transferred to Pescanova's Uruguayan affiliate (Belnova) for Atlantic swordfish operations.[770] The company has large, modern processing plants which work on its own catch as well as cultured harvests of salmon and other species (photo 121). Available information suggests that Pesca Chile does not conduct swordfish operations off Chile, but instead focuses primarily on groundfish, especially Patagonian toothfish--including Atlantic operations off the South Georgias.[771]

Pesca Cisne: This company has operated longliners (*Cisne Blanco* and *Cisne Verde*). The company in 1997 was one of five permitted to operate factory vessels.[772] There are no known swordfish operations.

Pesquera Apóstol Santiago: This Coquimbo-based company is owned by a Spanish citizen resident in Chile, José Castiñeira. According to one 1996 report, the company was operating two longliners for swordfish, *El Brisca* and *Kofuku Maru*. The company has declined to provide any details on their operations. The company is not listed as a swordfish exporter in available lists of Chilean companies (appendix H2).

Pesquera Atúnmar (PAM): This company was founded by Peter Shayne who played a role in other fishing and aquaculture companies in various Latin American countries. PAM, a multi-national company, helped to introduce modern longline fishing techniques to Chile. The company continues to be involved in the industry and exports fresh swordfish. It shipped over 150 t of fresh product in 1996, nearly a 70 percent increase over 1995 shipments (appendix H1a and figures 125 and 126).

Pesquera Calcurrupe: This company was reportedly operating the longliner *Niño de Corvo* for swordfish in 1996 (appendix A3b). The authors, however, can find no telephone listing for the company and as a result have been unable to speak to company representatives. It is not included on available lists of Chilean companies involved in the swordfish fishery (appendices H1a-b and H2).

Photo 121.--Pesca Chile operates longliners but for demersal species. The company's plant processes raw material from capture fisheries and salmon farms. Dennis Weidner.

Photo 122.--Pesquera Catalina works with artisanal fishermen who land swordfish during part of the season and then shift to demersal species. Dennis Weidner.

Pesquera Continental: This company processes frozen swordfish.

Pesquera Catalina: Pesquera Catalina is a processing and exporting company established in 1974. It is based in San Antonio and specializes in high-quality fresh and frozen fish. The company first handled swordfish in 1980 when it pioneered efforts to enter the U.S. fresh fish market, reportedly the first Chilean company to do so.[773] Pesquera Catalina was also responsible in 1982 for the first Chilean trials using driftnets to catch swordfish.[774] Pesquera Catalina works closely with the fishermen supplying fish in an effort to ensure the quality of raw material. As a result, the company has introduced a variety of gear, capture methods, and handling procedures. The company in 1995 had informal contractual relationships with about 35 artisanal boat owners who target swordfish with driftnets. The company processes fish trucked in insulated trucks from various Chilean ports. The swordfish is processed as loins and mostly exported to the United States. Small quantities are also exported to France, Japan, and Korea. The Japanese and Korean product is mostly belly flaps for sushi and sashimi. The exports are packed in boxes with gell-packs and transported to the nearby Santiago airport. During the peak of the fishery in 1991, Pesquera Catalina was processing 450 t of swordfish annually, but the quantity has declined substantially in recent years, especially in 1996 with the withdrawal of many artisanal fishermen from the fishery. The company exported only 40 t of fresh swordfish in 1996, a mere 15 percent of the more than 250 t shipped in 1995 (appendix H1a and figure 124). The company also processes tuna (primarily albacore), shark, and various groundfish (photo 122). The albacore is mostly shipped fresh to the United States and the shark shipped frozen to Spain.[775]

Pesquera Cuyaima: This company processes frozen swordfish.

Pesquera del Estrecho: This company in early 1996 was operating two 32-m longliners (*Curaco I* and *Talcan*) for swordfish out of Coquimbo (photo 123).[776] These freezer vessels currently land fresh fish and are equipped with ice making equipment. The vessels operate all along the Chilean coast, outside the 120-mile (192-km) coastal zone reserved for artisanal fishermen, from the Peruvian border south to Valdivia, currently as far as 960-1,280 km offshore. One company official reports that they average about 80 t of swordfish annually per vessel. The vessels will catch about 10 t on a 15-18 day trip.[777] Another company official reports trips of 25 days (20 fishing and 5 sailing days) and catch about 18 t of swordfish per trip. The fish reportedly average about 50 kg in size. The company makes up to 20 sets per trip, as many as 1 per day if everything goes perfectly, but this would be unusual. They average 9-10 trips annually per vessel. Swordfish is the target species, but several species of shark are also taken. The shark catch is discarded, except for the makos. All of the sharks, including the discarded ones, are finned. The makos are processed as H&G product which, like the swordfish, is exported. The shark by-catch varies from 1-6 t per trip. They also take some tuna, about 2 t per trip, mostly albacore and bigeye.[778] The company's two longliners were built in Spain in 1989, but for a variety of reasons the company tied up the vessels and leased them for several years instead of operating them itself. The company reactivated the vessels for 1996 operations targeting swordfish.[779] About 60 percent of the catch is exported fresh to the United States, 30 percent is exported to the European Union, and the remaining 10 percent is marketed domestically. The company participates in joint ventures with other companies to

Photo 123.--Pesquera de Estrecho operates two modern Spanish-built longliners in the swordfish fishery. Dennis Weidner.

export the catch.[780] The company reportedly has been associated with the Spanish company, Pesquera Española Bacalao.

Pesquera Esolmar: This problem-plagued company has a larger commercial longliner, the *Torres de Paine*. The vessel has been idled in San Antonio for some time (photo 124). The vessel was previously owned by Pesquera del Sur.

Pesquera Grimar: This company is headquartered in Santiago and operates processing plants in Concepción, Valparaíso, and Puerto Montt. It is one of the few processing companies which operates its own fishing vessels. The company runs processing lines for both fresh and frozen fish. The Puerto Montt plant processes mostly salmon and trout, but the Concepción and Valparaíso plants handle swordfish. The company was a major producer of fresh swordfish in 1994, but output dropped sharply during 1995 (appendices H1a-b and 2). Company officials visited the United States in late 1996 in an effort to expand export sales. The company is apparently experiencing financial problems and in 1997 sold much of its Patagonian toothfish quota to Pesca Chile.[781] Pesquera Grimar officials have declined to provide a description of the company.

Pesquera Iquique: This large fishmeal and canning company in 1991 opened a freezing line to produce bait for foreign longline fishermen. The company spent 4 months in 1990 experimenting with freezing bait to meet the needs of foreign fishermen. Sardines and mackerel were to be frozen for sale to fishermen in Japan, Spain, the United States, and other countries. The company's freezing lines include 18 APV-Baker Jackstone horizontal plate freezers with a daily capacity of 250 tons. This is reportedly the largest horizontal freezing installation in South America.[782] The company also reports small shipments of fresh swordfish (appendix H1a).

Pesquera Isla del Rey: This Valdivia-based company was established in 1989. It is involved in both the processing and exporting of swordfish, among other species. The company operates several longliners which it primarily uses to deploy bottom longlines for Patagonian toothfish. Isla del Rey also process and exports centolla, a species similar but smaller than Alaskan king crab.[783] The company purchases the catch of artisanal and commercial fishermen operating out of ports from Lebu north to Coquimbo. Most of the swordfish is handled from March and September when the artisanal fishery off the central coast is most active. Isla del Rey also buys some swordfish (mostly frozen) from commercial longliners during the rest of the year. They have an especially close relationship with the Pesquera Omega longliners. The company was exporting as much as 400 t of swordfish annually, but shipments have declined to only about 100 t in recent years. Shipments in 1996, however, increased somewhat to nearly 140 t in 1996 (appendix H1a and figure 124). Most of the exports are fresh loins shipped to the United States, but some H&G trunks are also shipped. The loins are vacuumed packed and shipped in cardboard boxes with gell-packs. The trunks are also shipped in gel-packs.[784]

Pesquera Lacks: This company was established in 1973. One erroneous report suggested that they process frozen swordfish. Company officials, however, report that they do not handle swordfish, but instead concentrate on frozen Patagonian toothfish, other demersal species, and salmon. They also smoke some salmon.[785]

Pesquera Marazul: This company was established in 1986 and has processing plants in Valparaíso, San Antonio, and Antofagasta. The company was owned by COPEC which is part of the Consorcio Angelini, a large Chilean holding company. Marazul operated Chile's largest fleet of vessels targeting swordfish.

The company fleet is composed of 10 vessels, both artisanal and commercial. Six artisanal vessels are all 18-m wooden vessels deploying driftnets in coastal waters. Four Japanese-built commercial longliners (*Mar Azul X, Mar Azul XII Mar Azul XIV*, and *Mar Azul XV*) varying from 42-46 m have been deployed in operations outside of Chile's 200-mile zone (appendix A3b). The longliners have crews of about 20. The commercial longline trips last 30-40 days and the vessels land both fresh and frozen product. Most of the catch is frozen, but the swordfish taken on the last few days of a trip is maintained fresh on ice. Catches averaged about 80 t of swordfish annually although this has declined in the past few years. Fishing methods are basically Spanish-style longlining, but the company declined to provide details on the gear and fishing methods. Marazul had been targeting primarily swordfish, but as the swordfish catch off Chile has been falling they have begun deploying bottom longlines for Patagonian toothfish and other demersal species. Some of the vessels have been transferred to Iquique Guanaye (a large fishing producing fishmeal and other products associated within the same holding company that controls Marazul). Iquique Guanaye has deployed the vessels in the south Atlantic. The declining availability of swordfish off Chile has caused Marazul to deploy its four longliners for bottom longlining, targeting Patagonian toothfish off Argentina during 1995 and 1996.[786] Marazul also buys swordfish from artisanal fishermen (landing at ports from Valdivia north to Coquimbo). The company contracts with Pesquera Santo Domingo in San Antonio to process the swordfish and works closely with the company to ensure the quality of the product.[787] Pesquera Marazul has been one of the major Chilean swordfish exporters. Much of its swordfish production was processed at its San Antonio plant and it also exports the product of other companies. Marazul was one of the few Chilean companies producing frozen swordfish in Chile and in the early 1990s about 90 percent of its output was frozen product. Now that the longliners have been redeployed for toothfish, most of the company's production is fresh loins. The company reports that it still exported some frozen swordfish after the redeployment in order to maintain contractual arrangements. They purchased this swordfish from artisanal fishermen. The major markets were the United States (fresh loins), Spain (fresh steaks and loins), and Argentina (frozen loins and steaks). Exports during the early 1990s totaled about 300 t annually, but are now substantially lower. The company produced most of Chile's frozen swordfish in 1994, but production fell precipitously in 1995 to only 6 t (appendices H1a-b and H2). One unconfirmed report suggested that the company was suspending swordfish operations in 1996, but company officials indicate that this was an erroneous report probably referring to the shifting of the longliners or the contracting of the processing to another company. Marazul reports that they are still very much in business.[788] The company reported fresh exports of over 60 t in 1996, down somewhat from 1995 levels and no frozen shipments in 1996 (appendix H1a).

Pesquera Montemar: This company was the fishing subsidiary of Empacadora Montemar. Pesquera Montemar operated the fishing vessels. The company was operated as two separate companies for tax purposes. Both divisions ceased operations in 1995. (See Empacadora Montemar above.)

Pesquera Omega: This company was opened in 1988 to target southern hake and other groundfish using U.S. (Alaska) vessels and methods. Pesquera Omega began swordfish operations in 1991 using two vessels. Unlike the artisanal fleet landing fresh fish, the company

Photo 124.--Pesquera Esolmar has tried to operate the problem-plagued Torres de Paine, seen here idle in San Antonio, but with little success. Dennis Weidner.

deployed freezer vessels landing frozen product, although they might land the fish taken at the end of the trip fresh. The company is owned by an U.S. family, the Schmidts, which have been involved in Chilean fisheries since the 1960s. Pesquera Omega was the first Chilean company to test U.S. swordfish longline methods using fewer hooks, but attaching light sticks and deploying monofilament line.[789] The company found that the U.S. methods resulted in higher yields. The bait used is usually horse mackerel ("caballa") and squid.[790] Pesquera Omega operated processing plants in Puerto Montt and Coquimbo, but most of the swordfish operations are conducted out of Coquimbo in Region IV (photo 125). (See "Ports.") The Puerto Montt plant processes mostly salmon and trout, but the Coquimbo plant processes swordfish. Pesquera Omega annually ships about 350 t of fresh and frozen swordfish. It is the principal Chilean company processing frozen swordfish, processing over half of all frozen exports in 1995 and over 40 percent in 1996 (appendix H2 and figures 124-126).[791] The company operates seven longliners, four of which target swordfish (*Betty, Isabel*, *Portugal II*, and *Tami-S* (appendices A3b and e). The *Betty* and *Isabel* are small 18-m fresh fish longliners and the *Portugal II* is a 26-m fresh fish longliner. These vessels operate out of Coquimbo. They average about 15 sets per trip. Upon landing the trunks are cleaned, boxed in gell-packs or dry ice, and trucked in insulated boxes to the international airport at Santiago, about a 6-hour drive. Fish are often landed at night, trucked to the Santiago international airport, and flown out the next day. A few trunks are processed into loins at the Coquimbo plant. Almost all of the export-grade product is sold in the United States, primarily Miami, Boston, and New York.[792] Pesquera Omega periodically deploys some of its vessels in the south Atlantic out of Montevideo. The *Portugal II* has occasionally been deployed in the Atlantic, but in 1996 was back in Chile and the company in early 1997 did not anticipate further Atlantic deployments. The largest Pesquera Omega longliner, the 48-m freezer factory vessel *Tami-S*, is routinely deployed in the south Atlantic. The vessel has operated in the south Atlantic from October to March when the fish are less available in the Pacific off Chile. The vessel is then redeployed off Chile from April to September.[793] The *Tami-S* while operating in the south Atlantic lands mostly frozen fish. It does not have a Uruguayan fishing license and thus has to operate outside Uruguay's 200-mile limit. Most of the swordfish catch is primarily exported frozen through Montevideo to Japan and Spain. The company reports higher operating costs in Montevideo than in Chile. Lesser amounts of swordfish are trucked to Santiago. Small quantities of fresh product are also landed which are mostly air shipped to the United States.[794] The company in 1996 decided to sell the Puerto Montt processing plant and focus on the swordfish fishery out of Coquimbo.[795]

Pesquera Sabropesca: This company processes frozen swordfish.

Pesquera Sarpesca: This company in 1997 received permission to operate the *Tuamapu*, in operations for tuna and related species around Chile's oceanic islands.[796]

Pesquera Santa Lucía (PSL): This Quintero based company conducted extensive fishing operations for a variety of species. The operations included longlining for swordfish. PSL operated fishing vessels such as the *Vamas II* and the *Lucia* which targeted swordfish off central Chile (appendix A3b). The company was one of the few Chilean companies to experiment with American-style longline methods. One unconfirmed report suggests that there was Dutch involvement in the company and at least one of the vessels were built in the Netherlands (appendix A3c). The swordfish vessels were often deployed from the company's San Antonio plant. The company participated in trails during 1990

Photo 125.--Pesquera Omega processes the catch of its swordfish longliners primarily in Coquimbo. Sebastian Vera.

which demonstrated the feasibility of using satellite data to find warm water plumes in the cold water off Coquimbo where swordfish could be targeted.[797] PSL's longline operations were initially centered off southcentral Chile. Since the feasibility of fishing off Coquimbo was established, PSL shifted operations somewhat to the northcentral coast. The company produced mostly frozen swordfish. The company ceased operations in September 1995, primarily as a result of closures in the shrimp and langostino fisheries and restrictions in groundfish fisheries. These species were of more importance to the company than the swordfish longlining and the decline of these fisheries severely impaired operations. PSL has sold its vessels and is selling its processing plant.[798]

Pesquera Santo Domingo (PSD): This San Antonio company processes a variety of fresh and frozen fish and specializes in swordfish. The company was established in 1987 and processed products for what they describe as three (Empacadora Montemar, Marazul, and New Bay Products) of the principal Chilean swordfish exporters in 1995.[799] These companies buy swordfish from artisanal fishermen and then contract PSD to process it after which the three companies arrange for the export sales. Company representatives claim that because PSD specializes in swordfish, it can produce a higher quality product than the other companies. There are also a variety of financial incentives for companies to contract the processing. Marazul recently had to close its San Antonio processing plant. By contracting PSD to process the swordfish, Marazul can continue to meet its export commitments even though its processing plant is closed. PSD also purchases fish directly from the artisanal fishermen and sells processed products to the exporting companies. PSD has a fleet of refrigerated trucks which picks up the swordfish at various ports and delivers it to its San Antonio processing plant. Much of the company's output (as much as 90 percent) is fresh loins destined for the U.S. market. They also handle some fresh H&G product which is mostly the smaller trunks landed. The trunks are all less than 120 kg as the larger trunks are too bulky for export shipment. PSD processes about 6.5 t of swordfish loins daily. Like other companies, the sharply reduced catches since 1991 is impairing business and the company is operating well below capacity.[800]

Pesquera Terranova: This company acquired the swordfish vessel *Isla Tabon* in 1997.[801]

Prod. y Comer. del Mar: This company exported small quantities of frozen swordfish in 1995 (appendix H1a).

SOPESCA-ALIMAR: This company, according to one 1996 report, was operating at least one longliner, *El Brisca*.[802] The vessel, however, does not appear to have been licensed for swordfish (appendix A3b).

Soc. Com. Frigorífico Valparaíso: This company processes frozen swordfish.

Sociedad Pesquera Mamiña: This company processes fresh and frozen swordfish.

Sociedad Reyes del Mar: This company operates fishing vessels which target swordfish, but does not process the catch.

Terramar: The former manager of Marazul in 1997 opened a new fish exporting company, Terramar. The company will handle swordfish, among other species. It will be associated with Cabo Azul, its fishing counterpart.

Other: A large number of other companies are active in the swordfish fishery (appendix H2). Most process or export only small quantities of swordfish. A few, however, are of some importance (appendix H1a), but have asked that their company name not be publicized.

B. Trade Associations

There are no active trade associations specifically representing the artisanal and commercial fishermen and companies involved in the swordfish fishery. An Asociación de Exportadores de Albacora (Swordfish) was formed in 1987 when the swordfish fishery was expanding and briefly worked to help promote the industry. The Association worked with government officials and helped to compile statistics, however, it appears to have ceased functioning in the early 1990s due to the significant decline of the fishery during recent years.

Several broad-based trade associations do represent the interests of companies and vessel owners involved in the fishery. The small swordfish fishery, however, is now a minor part of their activities.[803] The possibility of organizing a dedicated trade association has declined as the number of companies and artisanal fishermen participating in the fishery has fallen sharply due to the precipitous decline in the catch since the 1991 peak (appendix E2a1 and figure 91). The principal Chilean fisheries trade association is the Sociedad Nacional de Pesca (SONAPESCA). About 90 fishing companies belong to SONAPESCA, accounting for close to 70 percent of the country's fishery exports. SONAPESCA is primarily concerned with the large commercial fisheries in Chile, especially the small pelagic fisheries conducted for canning and fishmeal and oil production and more recently companies producing fresh and frozen product.[804] SONAPESCA has a limited interest in the swordfish fishery, but a few SONAPESCA members (Pesquera Catalina, Pesquera Grimar, and Pesquera Isla del Rey) are involved with swordfish. One major concern of SONAPESCA is foreign fishing off Chile.[805]

Swordfish vessel owners, especially the artisanal fishermen, belong to a variety of trade associations, many of which are centered at specific ports. These groups are not narrowly involved in the swordfish fishery because many of the artisanal fishermen only pursue swordfish seasonally.

Commercial: The authors know of no trade association representing the interests of the small number of companies operating commercial longliners (appendices A3b and e).

Artisanal: Several groups represent artisanal fishermen, including the fishermen operating driftnets for swordfish. The national association is the Asociación Nacional de Pescadores Artesanales de Chile (AMPACH), based in Talcahuano. The artisanal vessel owners in some ports have formed a variety of trade associations, many based on groups at individual ports. Only limited information is available on these groups.

APEVAL: One particularly active group is the Asociación de Pescadores de Valparaíso (APEVAL). The Association was founded in 1988 to represent the local fishermen when dealing with government agencies and currently has over 400 members who own about 50 vessels. The vessels range from 15-18 m in length. The fishermen conduct various fishing operations, including driftnet (swordfish), longline (shark, swordfish, and tuna), and trawl (hake, shrimp, and langostino). Two of their primary interests are improving port infrastructure and promoting exports. Swordfish is an important species for the fishermen, but its role has declined in recent years as the catch has fallen and members have withdrawn from the fishery.[806]

ASIPES: The Asociación Gremial de Industriales Pesqueros (ASIPES) also has members interested in the swordfish fishery, especially in the central and northern regions.

C. Cooperatives

Cooperatives do not play a significant role in the Chilean swordfish fishery. Fishing vessel owners in a few ports, however, have formed cooperatives. The only one known to the authors, at a port from which the swordfish fishery is conducted, is at San Antonio. The Cooperativa de San Antonio assists in marketing the catch or in helping negotiate a variety of contracts.[807]

D. Unions

Fishermen working aboard swordfish vessels have not exhibited great interest in trade unions. There is some unions activity. Many of the crew members in San Antonio, for example, belong to the Sindicato de Media Altura de San Antonio. This appears, however, to be more a social group than a militant labor union.[808]

XII. Markets

Chileans enjoy seafood, but the limited population requires that the great bulk of the fisheries catch be directed at export markets. Some high-value species, such as swordfish, are almost entirely exported.

A. Domestic

1. Seafood market

Fish is popular in Chile and consumption levels exceed those in the United States. Even so, Chile is a small country with a 1995 population of only about 14 million inhabitants. As a result, only a tiny fraction of the country's enormous fisheries production can be consumed domestically. Domestic consumption has been curtailed somewhat by price increases which have made fish increasingly expensive, thus limiting consumption. Chilean economic growth has benefitted many Chileans, and the country's growing middle class are expanding seafood consumption. A substantial portion of the population, however, still subsists on very low incomes and consume only limited quantities of seafood.

The country's seafood market is centered in Santiago where nearly a third of the country's population resides. Traditionally fish has been sold fresh in markets at landing sites ("caletas") or in central markets. Markets at ports and other landing sites offer a wide variety of seafood (photo 126). The customer's selection can be prepared to order at port markets (photo 127). Cooked meals are also commonly available (photo 128). The largest seafood market in Chile is in Santiago's Central Market, but all major cities have comparable central markets with seafood stalls (photo 129). The fresh market is dominated by hake and has been relatively stable in recent years.[809] Chile opened a major new wholesale fisheries market in the suburbs of Santiago during 1996. In recent years, Chilean fishing companies have begun to produce an increasing variety of high-quality frozen fishery products which is becoming popular,

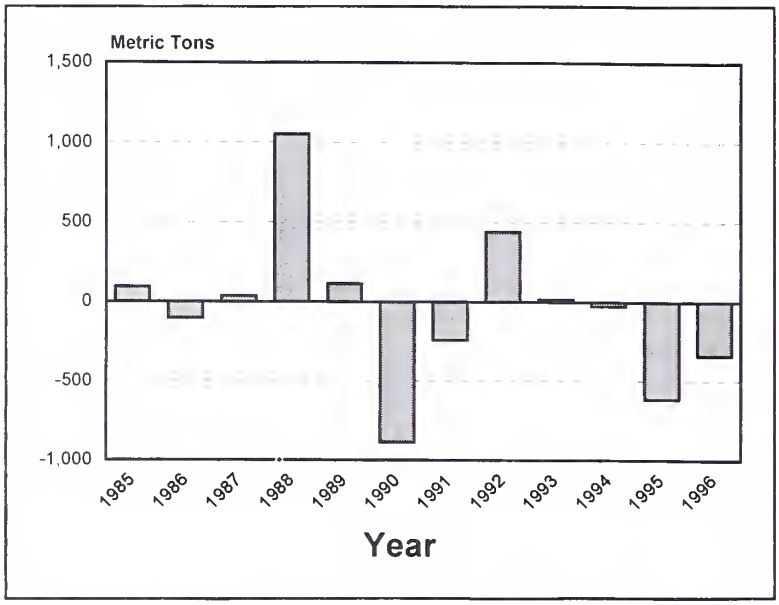

Figure 127.--Available statistics produce a confusing pattern concerning the quantity of swordfish available for domestic marketing.

Photo 126.--A wide variety of domestically caught seafood is available at Chilean markets. Dennis Weidner.

Photo 127.--Fresh fish can be purchased and cleaned to order at markets located at most fishing ports. Dennis Weidner.

especially with the country's expanding middle class. An increasing number of Chilean women are working and the convenience of frozen fish appeals to them. Modern supermarkets began to appear in Chile during the 1980s and they are becoming an important retail outlet.[810] Some of the most important Chilean supermarket chains are Econo, Santa Isabel, and Uimarc (photo 130). Santa Isabel also has stores in Peru. There are also some chains which are important regionally, such as Las Brisas in the growing Serena area. Several chains are important in the Santiago metropolitan area: Almac, Jumbo, Multi Oro, and Inicoop. Domestic sales of frozen fish primarily take place at these supermarkets and many of the more modern ones have added fresh fish counters in recent years. Almost all of the available seafood, even in the super markets, is domestic product.

2. Swordfish

Substantial quantities of swordfish were consumed in Chile through the 1950s. Apparently most of the 500-2,100 t of swordfish landed annually during 1938-52 was marketed domestically, primarily as fresh fish in local markets.[811] The authors have few details, but available reports indicate that the fish was also distributed in towns and at hospitals and even mines at some distance from the ports.[812] Substantial quantities of Peruvian swordfish beginning about 1949 was exported to the United States. The authors have not found any reference to Chilean exports at this time, but the available information is incomplete, so such shipments may have occurred.

Only small quantities of swordfish are currently marketed in Chile. Some companies report marketing about 10 percent of their swordfish catch in Chile.[813]

Photo 128.--Cooked meals are available at most port-side markets. Dennis Weidner.

Photo 129.--The traditional source of seafood in Chilean cities are central markets like this one in Valparaiso. Dennis Weidner.

***Photo 130.**--Chilean consumers, especially middle-class consumers, are increasingly shifting to supermarkets, many of which have fresh fish counters. Dennis Weidner.*

***Photo 131.**--Swordfish is rarely available in Chilean markets as almost all the catch is exported. Dennis Weidner.*

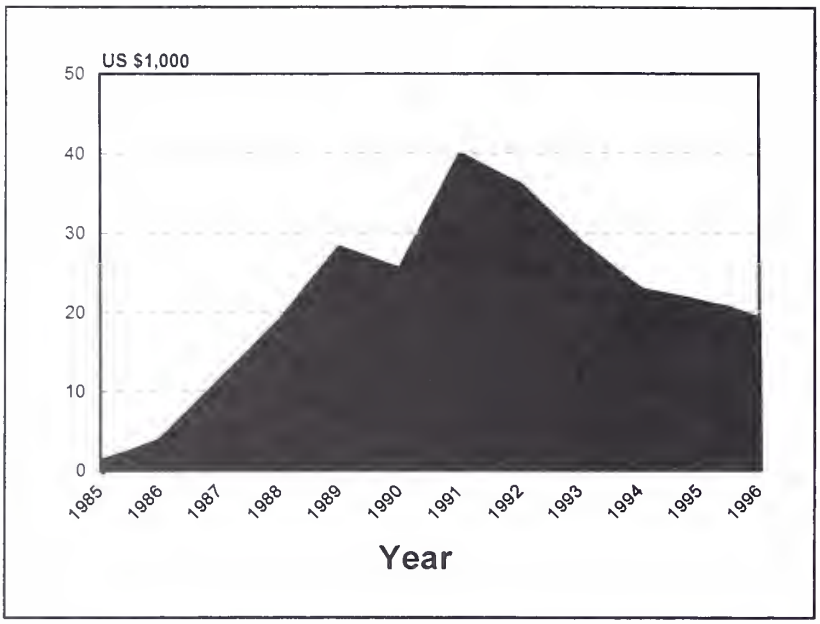

Figure 128.--Chilean swordfish exports, like the catch, peaked in 1991. The value of shipments continued to fall in 1996, despite the catch increase.

B. Trade

1. Exports

Chilean companies in recent years began exporting swordfish in 1983. The first shipments were to the United States. The success of these initial shipments and high prices encouraged fishermen to expand fishing operations. The introduction of modern gear and methods enabled the fishermen to rapidly increase catches. (See "Catches.") This provided the raw material for greatly expanded export shipments. Shipments were negligible in the early 1980s and did not begin to grow significantly until 1986 when they first exceeded $1 million in 1986. Exports in that year totaled $3.8 million. Shipments rapidly continued to expand for several years, exceeding $10 million in 1987 ($11.3 million), $20 million in 1989 ($28.1 million) and approached $40 million in 1991 ($39.7 million) (appendix J2a and figure 128). Substantial difference exist between U,S. and other foreign import data and Chilean export data (appendix J2d and figure 129).[815] Shipments have since declined sharply, especially after 1992 to only $22.8 million in 1994. Export shipments declined slightly in 1995. Smaller shipments were compensated for by higher prices. Shipments dropped even more in 1996 to only $19.1

Most of the swordfish marketed domestically is fish which is not of export grade, often trunks which have minor shark bites. Available statistical data provides curious numbers on possible domestic marketing (appendix J2i and figure 127). Swordfish is not generally available in port markets, central markets, or supermarkets (photos 131).[814] The high international prices available for this species is well above domestic seafood prices, providing a powerful incentive to export as much as possible of the export grade product. Some damaged or low quality swordfish, however, may appear in local retail markets. Swordfish is occasionally available in white table cloth restaurants, mostly in Santiago. This is probably cuts from damaged trunks marketed domestically.

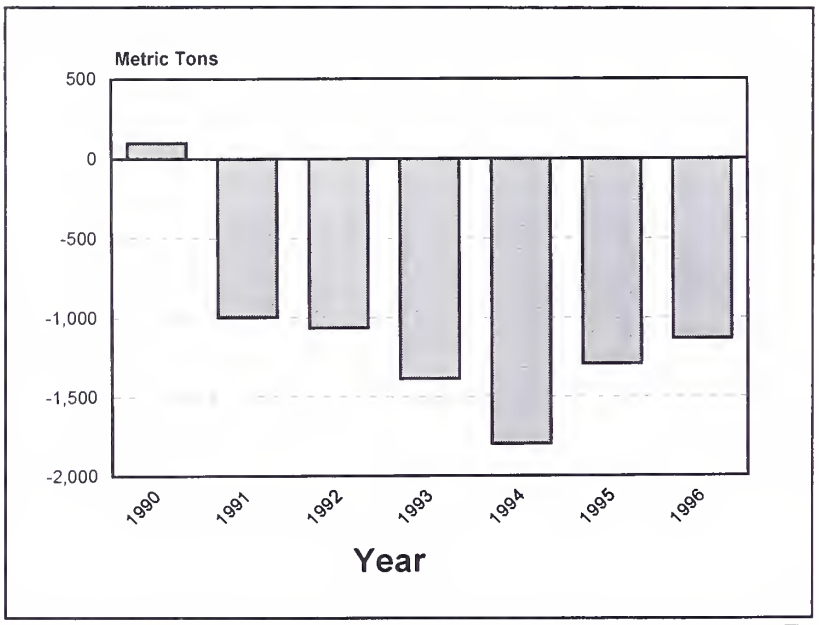

Figure 129.--Significant disparities exist between Chilean export and U.S. import data. The author believes the Chilean data is probably more accurate.

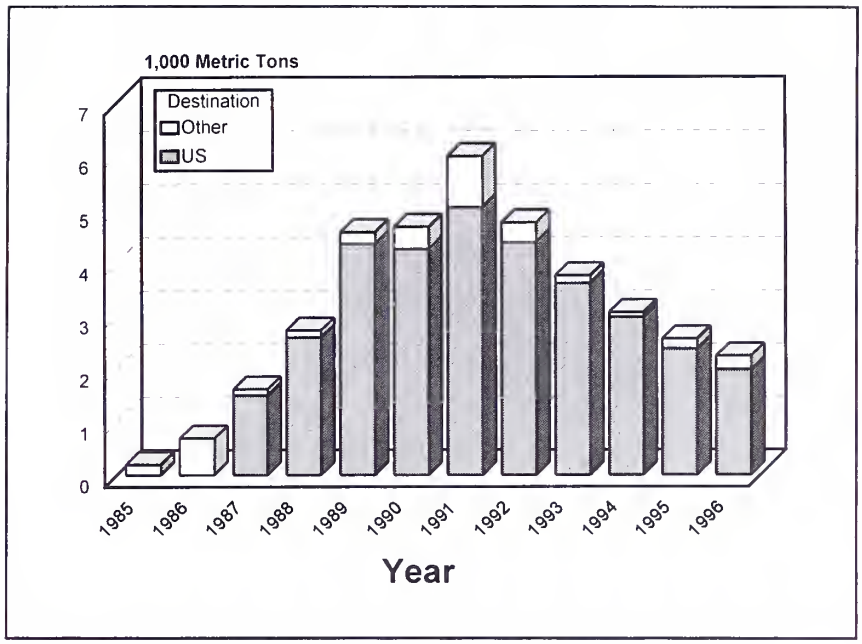

Figure 130.--The United States is the principal market for Chilean swordfish exports.

million, despite the catch increases. The principal export market continues to be the United States (appendix J2e and figure 130).

Chile currently exports most of its swordfish as fresh product. Usually more than 90 percent of all exports are fresh product (appendices J2a-b and figure 131). Shipments of frozen swordfish increased during the early 1990s as companies acquired commercial longliners for offshore fisheries. Much of the initial production of these vessels was frozen. As a result, Chilean exports of fresh swordfish declined to only 76-84 percent during 1990-92. Prices for frozen product fell sharply in 1993 to $1.40 less than that of fresh product (appendix G4a and figure 123). This decline, especially in relation to fresh product, caused most companies to begin shifting their longliners to fresh fish operations. Companies have thus increased the proportion of fresh exports which reached 91-93 percent during 1994-96 (appendix J2b and figure 131). The price difference between fresh and frozen product widened in 1995 to more than $3.00 and moderated only slightly to $2.70 in 1996 (appendix G4a and figure 123). This partially explains the extremely low level of frozen exports during 1994-96.[816]

a. Markets

Chile's only significant swordfish market is the United States, both for fresh and frozen product. The established trading patterns, easy market access, transport links, and especially the high prices available for swordfish have attracted almost all of the potential Chilean product. Some product has been marketed in the Eeropean Union, but almost all Chilean fresh product is currently marketed in the United States (appendix J2c2 and figure 132). The Chilean market for frozen product is somewhat more diverse, but is now a relatively small part of the country's overall shipments (appendix J2f1 and figure 133). Prices for fresh product are relatively comparable in most export markers, but frozen prices are more variable (appendix J2f3 and figures 134 and 135).

United States: The United States is the primary market for Chilean swordfish. The United States has a substantial domestic swordfish fishery (photo 132), but it does not fully supply the massive domestic demand for the species which is highly prised by consumers.[817] Swordfish is one of the most popular seafoods in the United States and domestic or imported product is available in most U.S. seafood markets or supermarkets with fresh seafood counters (photos 133 and 134). Normally about 90 percent or more of Chilean swordfish shipments are marketed in the United States (appendix J2 and figure 136). An even larger proportion of fresh shipments is marketed in the United States (appendix J2f1 and figure 130). Chilean exporters have some advantages in the U.S. fresh market because the peak Chilean season (March-July) comes earlier than the peak of U.S. Atlantic coast landings (August-September).[818] Chile began to export swordfish to the United States during the mid-1980s. Shipments increased from negligible levels to a record 5,040 t in 1991 valued at $34 million (appendix J2e and figure 131). U.S. import data shows only about $25 million in 1991 (appendix J3c2 and figure 137), but the authors believe that some swordfish, especially processed product is not being correctly identified.[819] At the peak of the fishery, Chilean exporters were playing a major role in the U.S. market, and Chilean production had a substantial impact on U.S. prices. Chilean exporters supplied half or more of the fresh swordfish imported by the United States during 1988-92 (appendix J3c2 and figure 137). Chilean fresh product accounted for over 70 percent of total U.S. imports in 1989. Since 1991 shipments have declined sharply as catches and the supply of raw material have fallen. Chilean exports to the United States totaled only 2,400 t in 1995 valued at $20 million. A major decline in Canadian shipments permitted Chile to emerge and the leading supplier to the U.S. market in 1996 (appendix

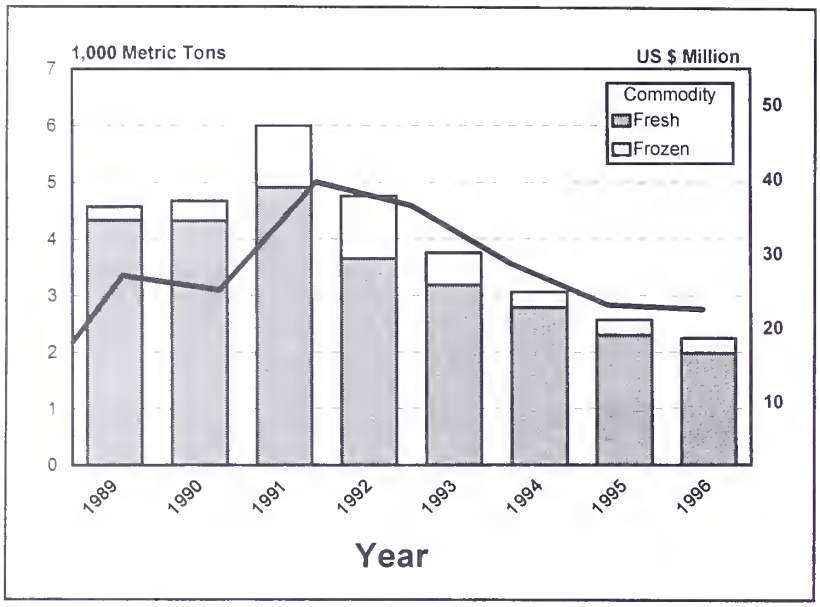

Figure 131.--Swordfish exports have steadily declined since 1991 as has the proportion of frozen product.

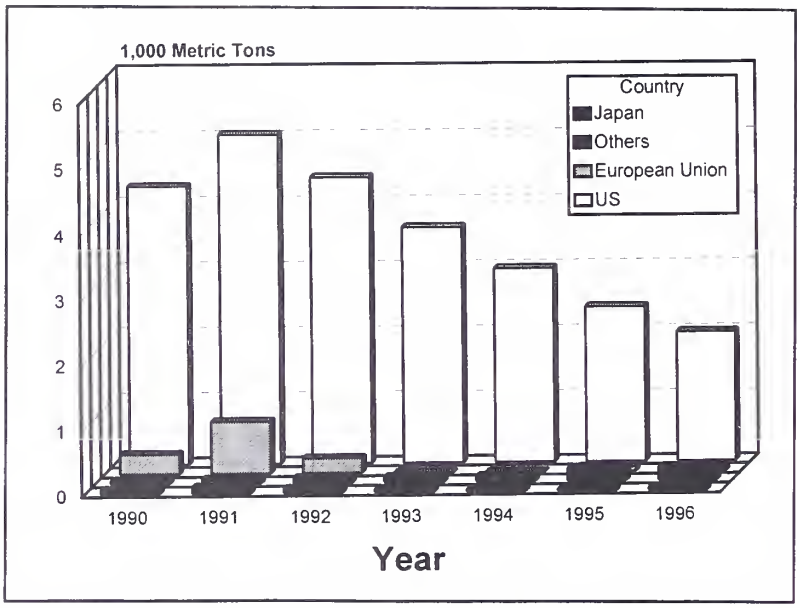

***Figure 132.**--The United States is the only important market for Chilean swordfish, but some significant quantities have been shipped to the European Union.*

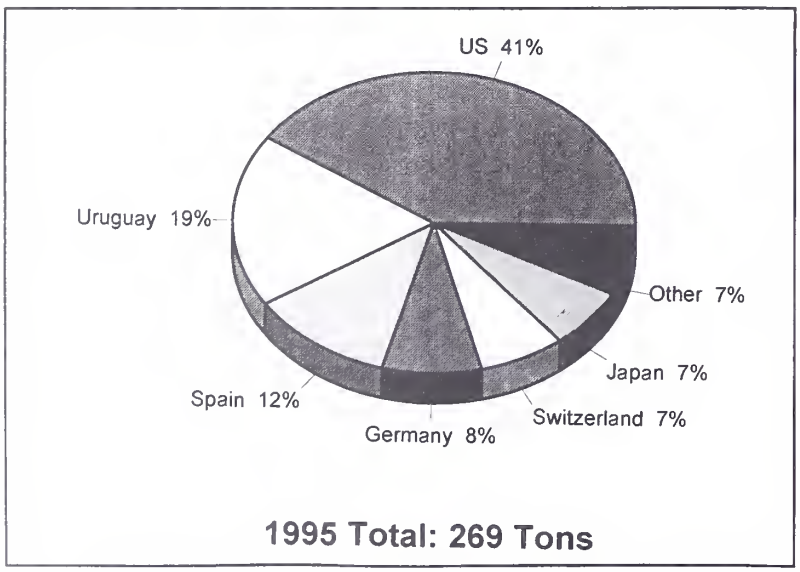

Figure 133.--Chile's markets for frozen swordfish are more diverse than for the fresh product.

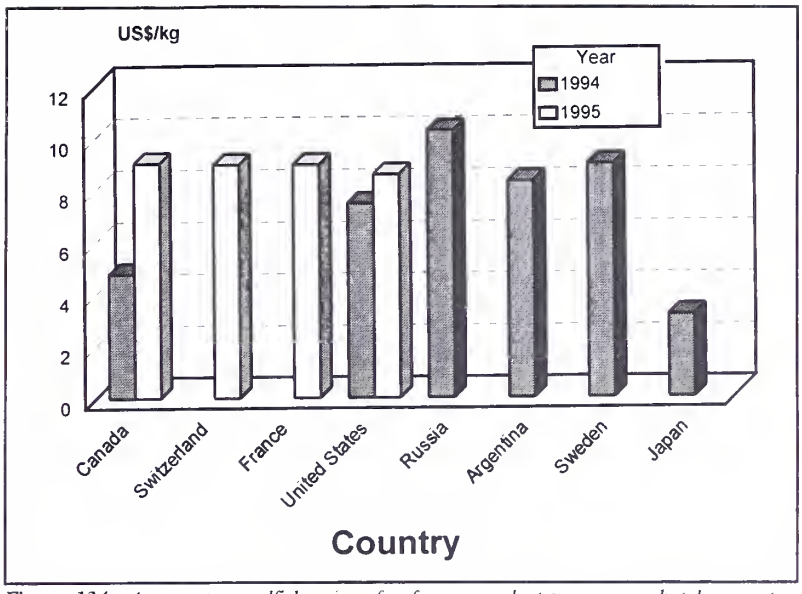

Figure 134.--Apparent swordfish prices for frozen product vary somewhat by country. Japanese prices, in particular, appear low.

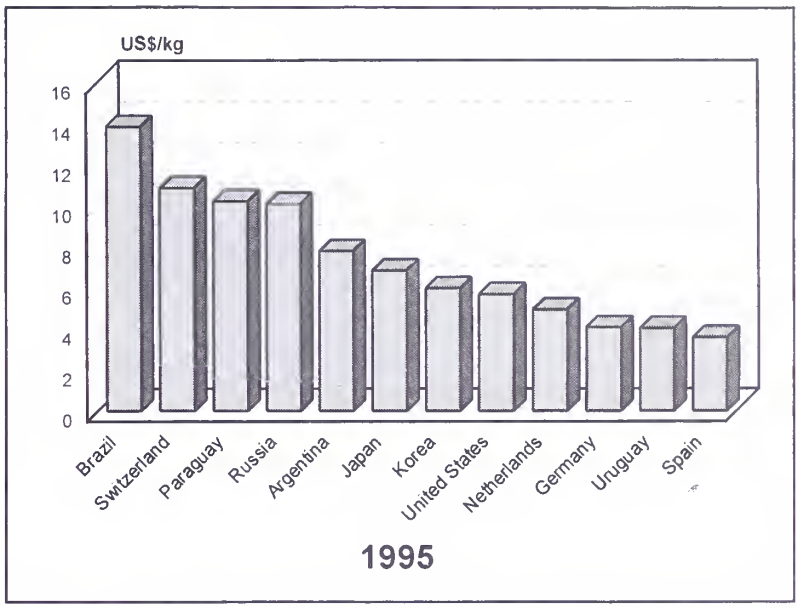

Figure 135.--High prices for frozen product are reported by several countries importing small quantities.

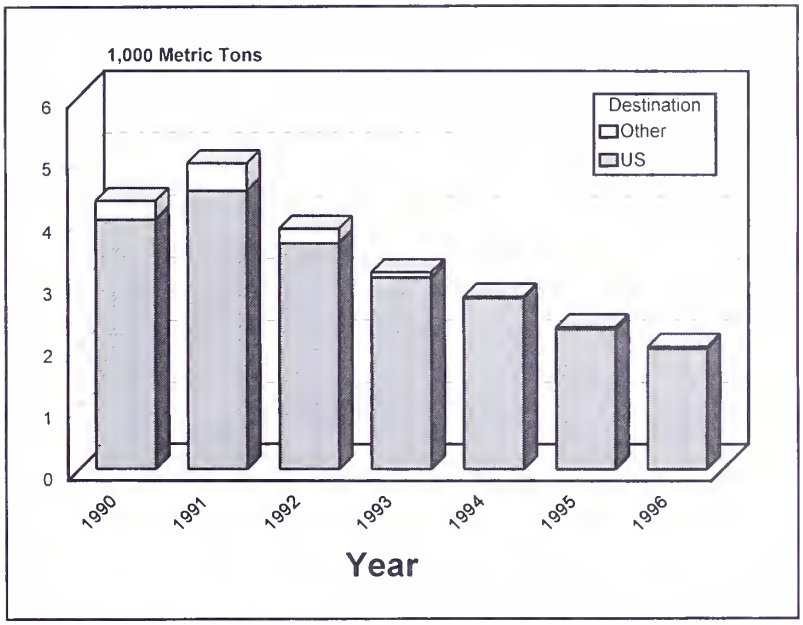

Figure 136.--U.S. importers have virtually ceased purchases of frozen product from Chile.

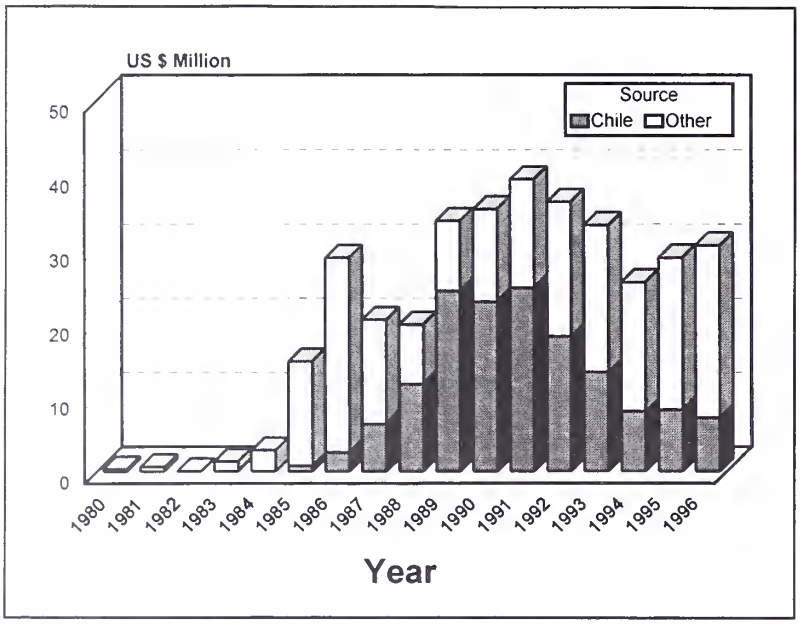

Figure 137.--Chilean exporters dominated the U.S. swordfish market in the early 1990s, but catch declines mean that they currently play a much smaller role.

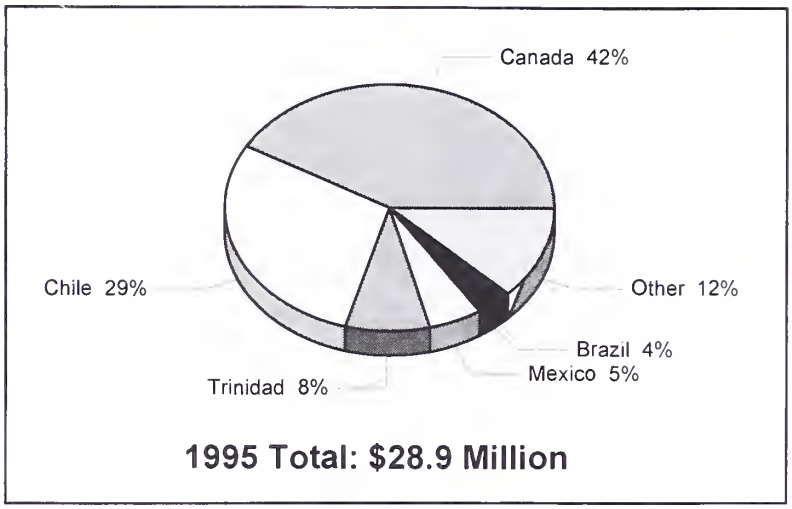

Figure 138.--Canada has dominated the U.S. swordfish market in recent years.

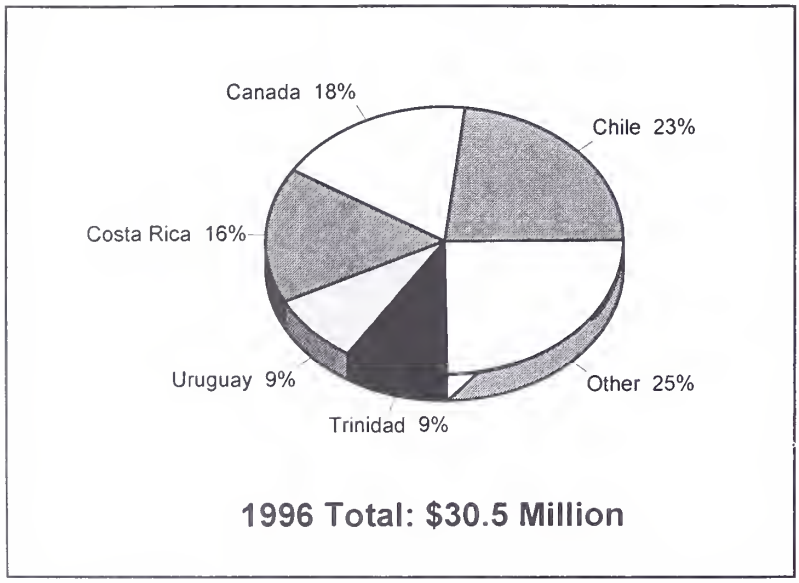

Figure 139.--Declining Canadian production in 1996 permitted Chile to emerge as the leading supplier of swordfish to the U.S. market in 1996.

***Photo 132**.--The Pacific coast U.S. longline fleet targeting swordfish is primarily based in Honolulu. Dennis Weidner.*

***Photo 133**.--Swordfish is one of the most popular seafoods in the United States and is commonly available in most seafood markets. Dennis Weidner.*

Photo 134.--An increasing number of U.S. supermarkets have fresh food counters and swordfish is a commonly stocked product. William Folsom.

commodities (appendix J3e1).[820] Canadian fresh swordfish tends to sell for about $2.00/kg more than Chilean fish. Swordfish from many other countries, especially Latin American countries sell at prices substantially below that of the Chilean product (appendix J3e2). To some extent this is a reflection of varying product forms. Much of the Chilean product is processed into value added forms (appendices J2h1-2 and figures 141-142). Swordfish from other Latin American countries are primarily

J3c1 and figures 138-139). The primary reason for the decline is the falling Chilean catch (appendix E2a1 and figure 91). Demand in the United States remains strong. The great bulk of shipments to the United States is fresh product, usually more than 90 percent (appendix J3a1 and figure 140). Frozen shipments increased somewhat during the early 1990s as Chilean companies began to deploy longliners producing frozen product. Canada and Chile are usually the two principal suppliers with the highest prices because of their quality standards and product mix of value-added

shipped as unprocessed trunks. Frozen products reached a peak of about 25 percent of shipments in 1992. The Chilean longliners have since shifted primarily to fresh fish operations. As a result, frozen shipments to the United States have declined sharply. Fresh shipments in 1995 were about 95 percent of all swordfish shipments and increased to 98 percent in 1996 (appendix J2f1 and figure 136). Most of the Chilean fresh shipments in 1996 were air freighted to Miami with lesser quantities entering through other cities, primarily Los Angeles and New York (appendix J3b and figure 143). New York had been an important port during the early 1990s, but after 1993, quantities declined sharply. Some observers indicate that Chilean exporters have been able to negotiate excellent rates from air carriers because of an unbalance in shipments to and from the United States.[821] The primary U.S. markets are white table cloth restaurants and supermarket chains. Although it is common for U.S. fishermen to market their entire catch at one price, domestic swordfish marketers have established different pricing for three size classes of trunks (dressed fish). **Markers** are about 45 kg (100 lb) or more and are the most valuable because uniformed-

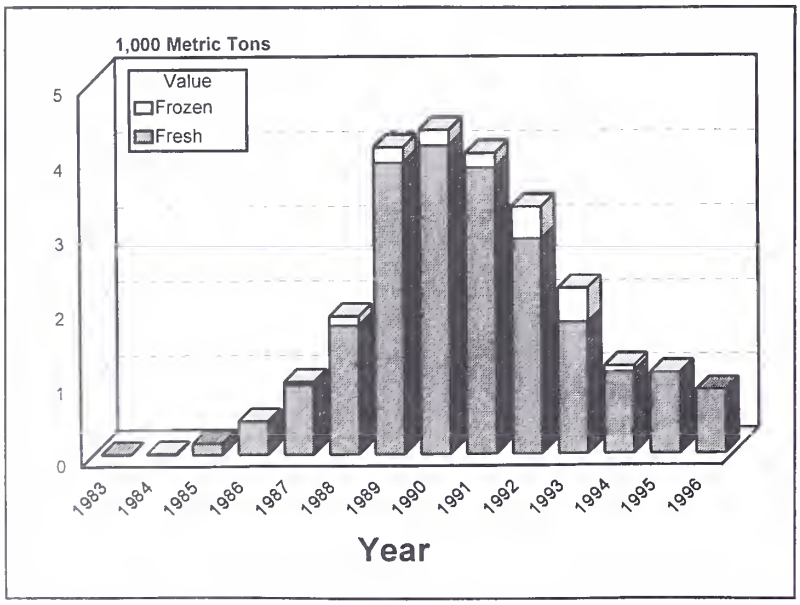

Figure 140.--U.S. import data shows the same general pattern as Chilean data, although the quantities are somewhat less.

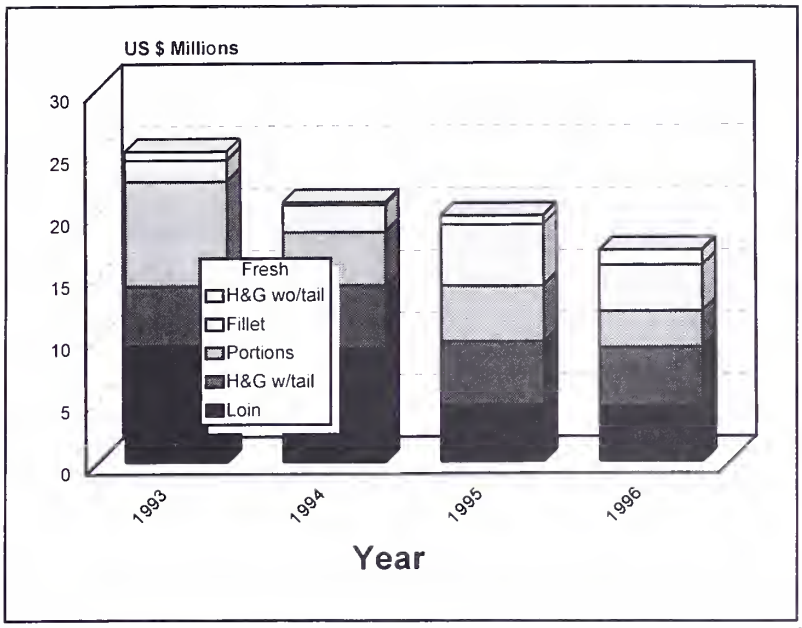

Figure 141.--Chile processes value-added swordfish products, but the proportion of unprocessed headed and gutted trunks is increasing.

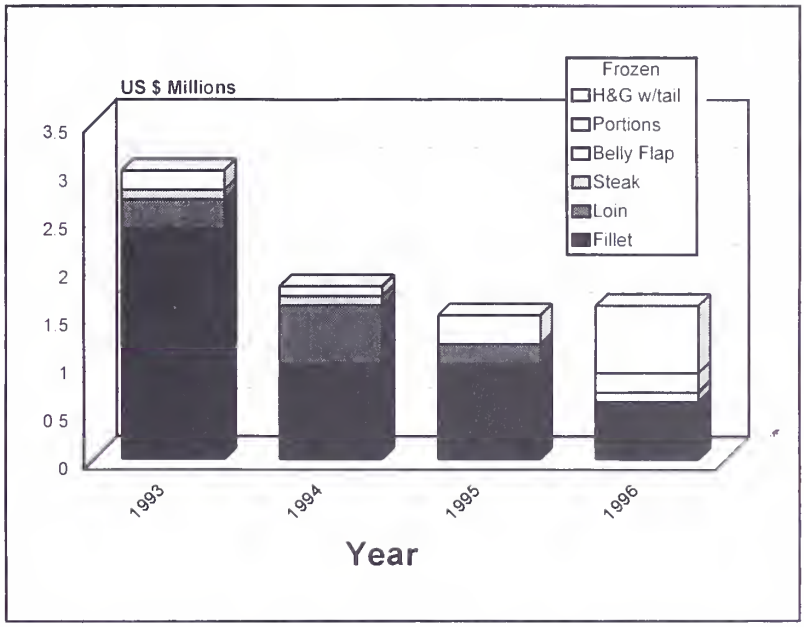

Figure 142.--Chilean companies are also shipping a greater proportion of frozen H&G trunks.

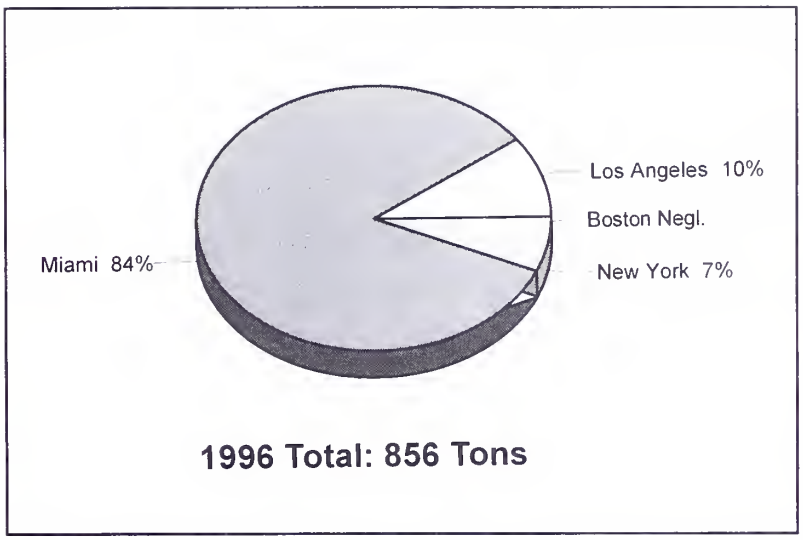

Figure 143.--Most of Chile's swordfish exports to the United States are shipped through Miami.

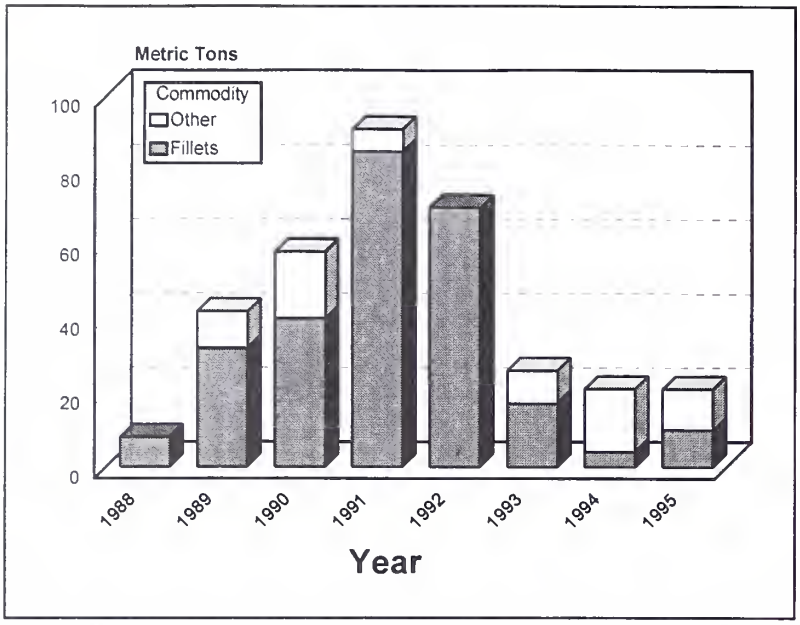

Figure 144.--Japan imports frozen swordfish from Chile and in some years much of it in processed forms.

sized dinner portions can be cut with a minimum of offcuts and odd-sized portions. The center sections of large loins are the premium cuts. **Pups** are from 23 kg (50 lb) to 45 kg and are less valuable because of the smaller yields of uniformly sized portions. **Rats** are the smallest size, about 11 kg (25 lb) to 23 kg and the least valuable because of the low yields of uniform portions. Food service and buyers for retail outlets will usually not purchase this size because such operations require large portions of uniform size.[822]

Japan: Chilean swordfish exports to Japan are minor and have never exceeded 100 tons. In recent years shipments have been only 20-30 t (appendix J5a and figure 144). Chile has exported small quantities of swordfish to Japan since the mid-1980s, almost all frozen product.[823] Shipments of fresh product are minimal, probably due in part to the logistical difficulty involved in shipping fresh product to Japan in contrast to the comparatively easy access to the strong U.S. market. Japanese consumers prefer red-flesh to swordfish for high-end products like sushi and sashimi. Shipments to Japan in the 1990s have ranged from a peak of 98 t in 1991 to a low of 18 t in 1995 (appendix J2f1 and figures 132 and 144). The 1991 peak coincides with the peak of Chilean commercial longline operations which produced most of the frozen product (appendix E2f and figure 64). Shipments have steadily declined since 1991 to the small 1995 shipments. As with the United States, some differences exist between Chilean export and Japanese import data (appendix J5c). The Japanese data, however, generally confirms the small quantities involved and the trade patterns reported by Chile (appendix J5a and figure 132). Most of the exports to Japan in some years have been fillets, although the proportion has declined in 1994-95 (appendix J5b and figure 144). Chilean companies report shipments of belly flaps ("estomogos") to Japan which are used in sushi and sashimi.[824] These are probably included in the fillets category.

European Union: Chilean swordfish exports to the European Union (EU) are normally limited, but in some years have exceeded 800 t (appendix J4b and figure 145). Shipments peaked in 1991 at over 800 t and then dropped precipitously to 230 t in 1992. Shipments in 1993-94 were extremely limited, but 65 t was shipped in 1995. Chilean companies have exported to most of the larger EU countries, except the United Kingdom. Shipments in 1996 were minimal.

Spain: The great bulk of the shipments to the EU, however, were primarily to Spain during the period (1990-92) in which significant quantities were being exported (appendices J4a-b). Shipments in 1996 totaled only 5 t of fresh product (appendix J2f1).

France: Anecdotal reports in 190 suggested some French interest in vacuum packed fillets.[825]

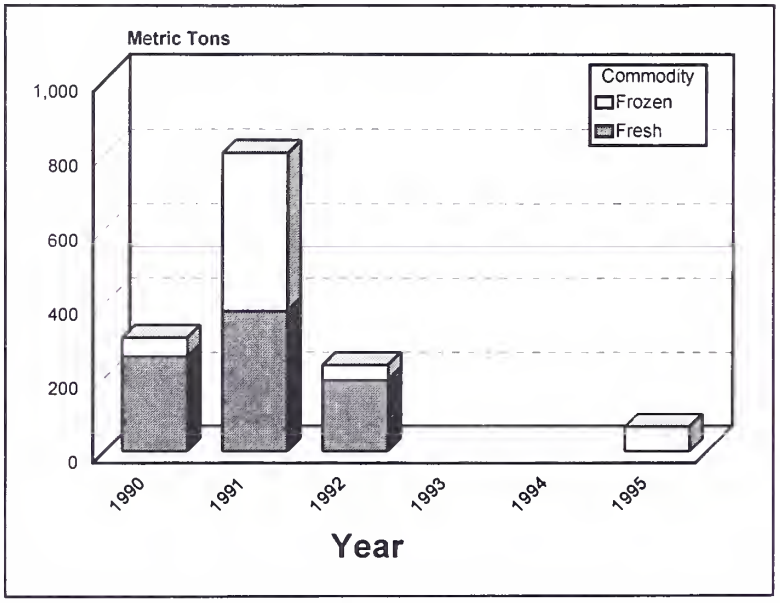

Figure 145.--Chile has shipped little swordfish to Europe since 1992.

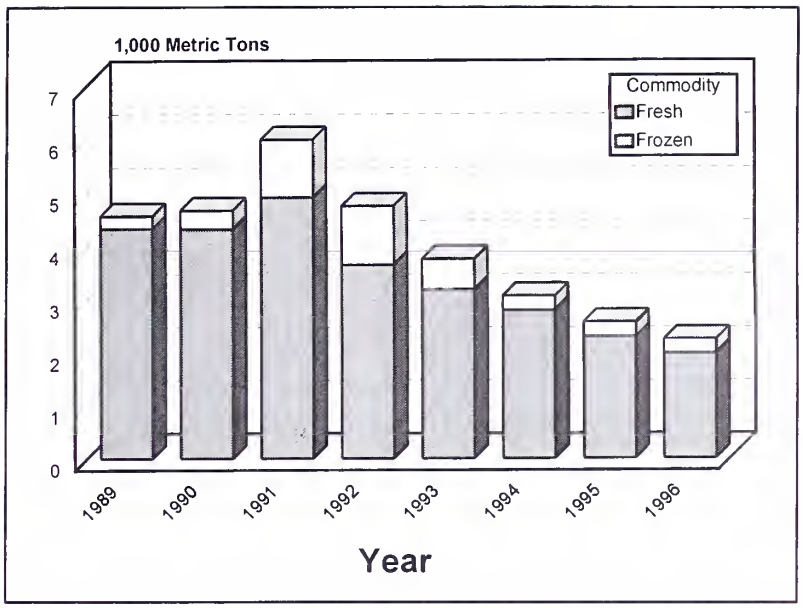

Figure 146.--The quantity of swordfish exports has steadily declined since 1991. Frozen shipments have declined to minimal quantities, but have been stable since 1994.

Shipments to France, however, have been limited and appear to have ceased after 1992.

As with the United States, some differences exist between Chilean export and EU import data (appendix J4c). The EU data, however, generally confirms the trade patterns reported by Chile (appendices J4a-b and figure 132). Most of the exports to the European Union in some years have been fillets, although the portion declined during 1994-95 (appendix J5b). Chile has exported both fresh and frozen swordfish to the European Union, but since 1993 the shipments have been entirely frozen product (appendix J4b and figure 145). No details are available on the product form of the fresh shipments, but the frozen shipments were mostly trunks and very small quantities of meat and fillets (appendix J4a).

Other: There are no significant Chilean swordfish markets besides the United States. Even the major seafood markets of Japan and Europe account for very limited export shipments. Chilean exporters, however, do market extremely small quantities of product in a wide variety of other countries. These other countries in 1995-96 included Uruguay, Canada, Spain, Switzerland, and Suriname (fresh product) and Uruguay, Switzerland, Argentina, Korea, Brazil, and Russia (frozen product) (appendices J2f1-2). The 1995-96 shipments listed for Uruguay appear to be the landings and transshipment of the Chilean vessels operating out of Montevideo and not product actually marketed in Uruguay.[826] (See "Transshipments".)

b. Product form

Chilean companies export both fresh and frozen swordfish, but fresh product is currently the dominate commodity. In recent years 85-90 percent of Chilean swordfish has been exported as fresh product. Most of the Chilean swordfish shipments are currently fresh product and much of it consists of value-added product forms, especially fillets and loins, although the proportion of trunks processed has been declining in recent years (appendices J2h1-2 and figure 141).

Fresh: Fresh product dominates Chilean swordfish exports. Fresh shipments are generally 90 percent or more of Chilean exports, although unusually large amounts of frozen product were shipped in the early 1990s (1991-92) (appendix J2b and figure 146). Fresh shipments during recent years (1994-96) have exceeded 90 percent of overall swordfish exports. The great bulk of the fresh exports is shipped to the United States. Shipments to the United States in 1994, for example, accounted for nearly 99 percent of all fresh swordfish shipments (appendix J2f1 and figure 136). The popularity of swordfish in the U.S. market and the ease of air shipment suggest that this pattern will continue for some time. A substantial portion of the export shipments are processed into value-added product.

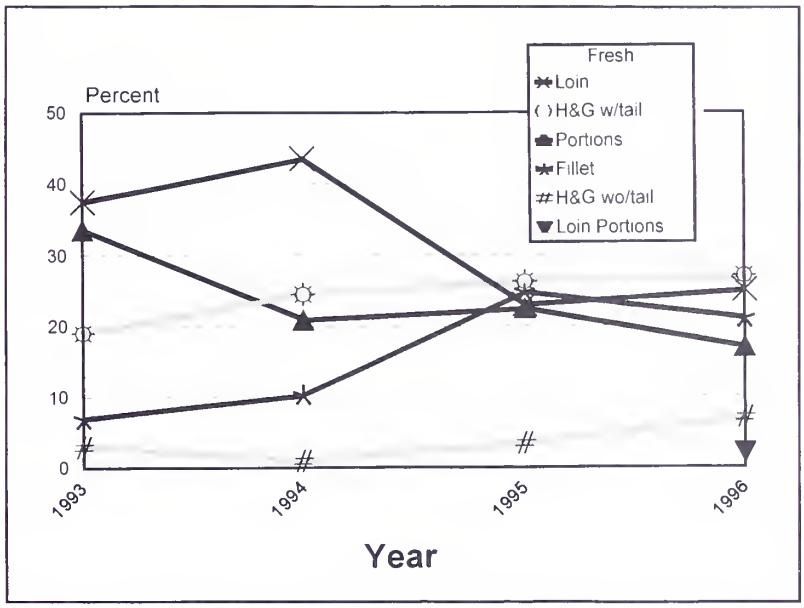

Figure 147.--The quantity of processed value-added products like loins has declined since 1994.

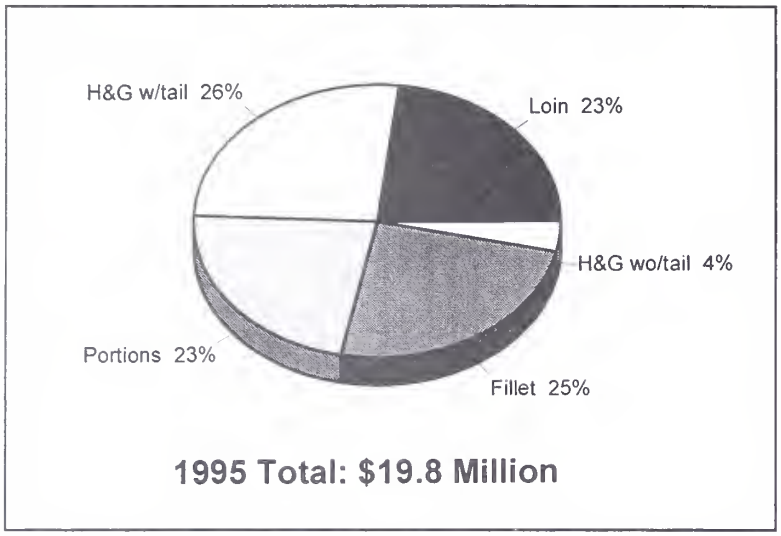

Figure 148.--Chile exports a wide variety of processed and unprocessed swordfish products.

Only 23 percent of 1993 shipments, for example were H&G trunks (tail on and off) (appendices J2h1-2 and figure 141). Most of the fresh product is shipped as loins, portions, and fillets. Fresh loins alone totaled 40 percent in 1994. The relative importance of these and other product forms varies from year to year. One clear recent trend is the increasing proportion of unprocessed trunks being shipped since 1993. The proportion of fresh H&G trunk shipments has increase steadily and totaled 36-40 percent by value in 1995-96 (appendix J2h2 and figure 147). The trend is the same in value terms, but only about 30-35 percent of total fresh shipments (appendix j2h2 and figures 148-149). Fresh loins declined to only 23-25 percent in 1995-96. This shift appears to reflect an increasing tendency of U.S. importers to order trunks rather than processed product. Many U.S. importers have apparently concluded that handling the whole unprocessed trunk and its immediate shipment will mean a higher quality product. Even if processing in the United States is more expensive, the higher quality product appears to more than compensates for the increased costs.[827]

Frozen: Frozen product is currently of only minor importance to the swordfish fishery. Frozen exports increased during the late 1980s and early 1990s as commercial fishermen acquired longliners with freezers. Frozen production, however, peaked in 1991-92 at 1,100 tons. It has subsequently declined to extremely low levels, below 10 percent of total shipments (appendix J2b and figure 146). The sharp decline in prices for frozen swordfish in 1993 (appendix J3d and figure 150) is one of the principal reasons for the reduced exports. Many commercial fishermen shifted to other fisheries are suspended operations because of the low prices. (See "Catch.") Chile only exported 270 t of frozen swordfish in 1995 (appendix J2b and figure 146). The United States is also the principal market for frozen exports, but shipments have declined since 1992. A variety of other markets are becoming more important, although the quantities involved are small. Frozen shipments to the United States in 1994, for example, were still over 75 percent of all swordfish shipments. This is variable, however, and only about 40 percent of the small quantity shipped were exported to the United States during 1995 (appendix J2f1 and figure 133). The U.S. share dropped even more in 1996, in part because transshipments through Uruguay were being counted as exports to that country. Notably, apparent prices received for frozen product marketed in the United States were lower than for most other countries, but the prices were highly variable (appendix J2f3 and figures 135 and 151). This probably reflects varying product mixes. Shipments of value-added product to one market may explain the high prices noted. Frozen product is shipped in several product forms, but more than half of all shipments are fillets. Loins and H&G trunks are the only other important frozen products. Shipments of frozen trunks

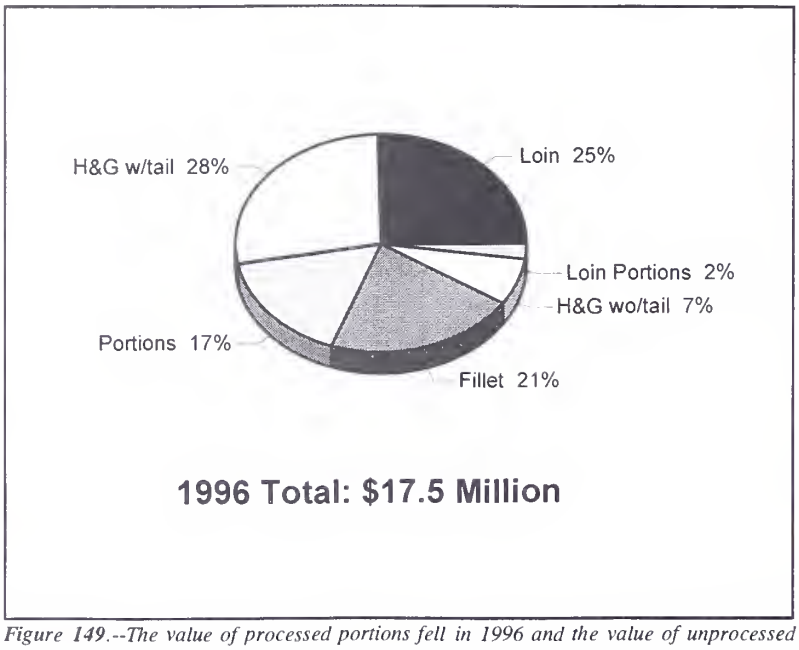

Figure 149.--The value of processed portions fell in 1996 and the value of unprocessed H&G sharply increased.

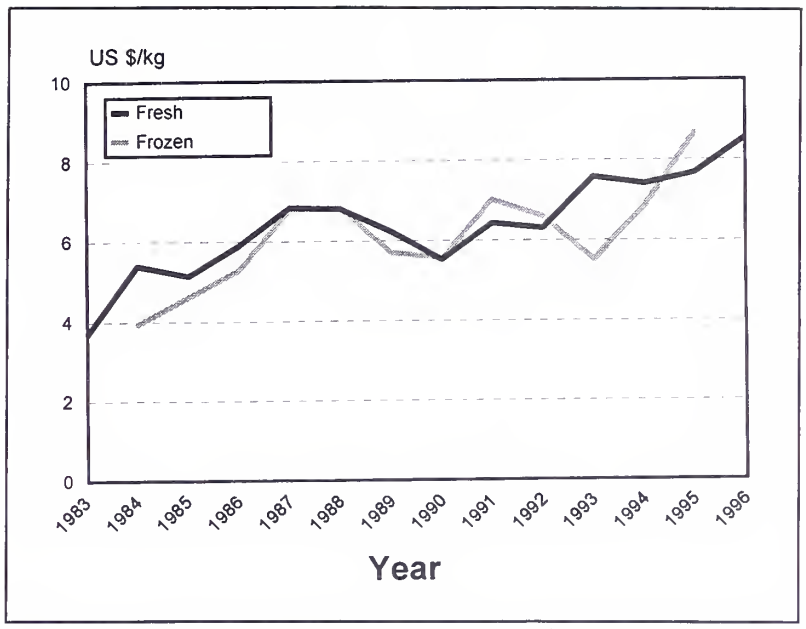

Figure 150.--The value of U.S fresh product imports is increasing. Frozen price fluctuations are due to product form variations and the small quantity imported.

increased in 1995 to nearly 20 percent and in 1996 even more to over 40 percent of the total value (appendix J2h2 and figures 152-154). The 1996 increase in frozen shipments reflects the greater importance of the freezer longliners. While they were primarily landing fresh product in 1996, many vessels froze the catch during the first few days to assure product quality during long off-shore voyages. As a result, there was considerably more frozen trunks available for export in 1996. (See "Catch".)

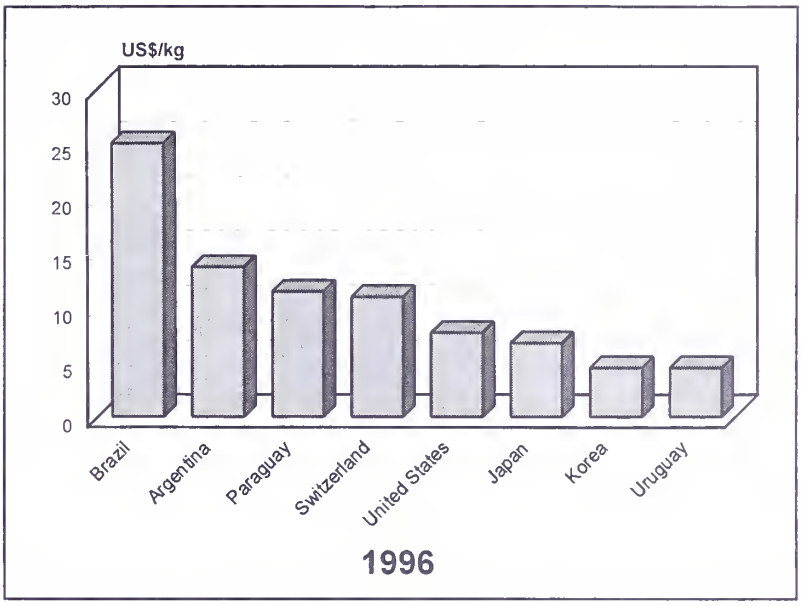

Figure 151.--Frozen swordfish prices vary considerably from country to country, but the quantities are often quite small.

2. Imports

Chile does not import swordfish.

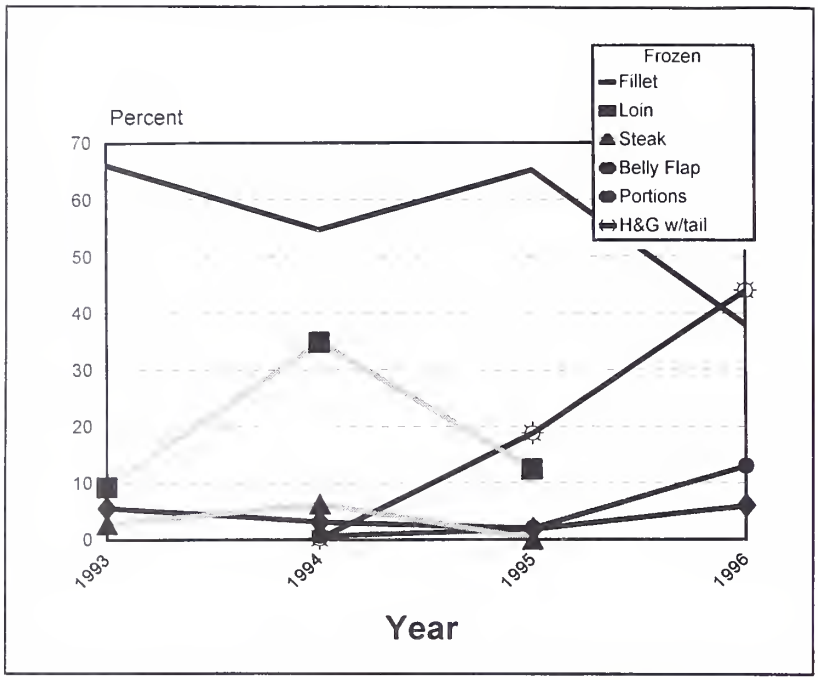

Figure 152.--The value of frozen fillets has plummeted, but frozen H&G trunks in 1996 was nearly half of all shipments.

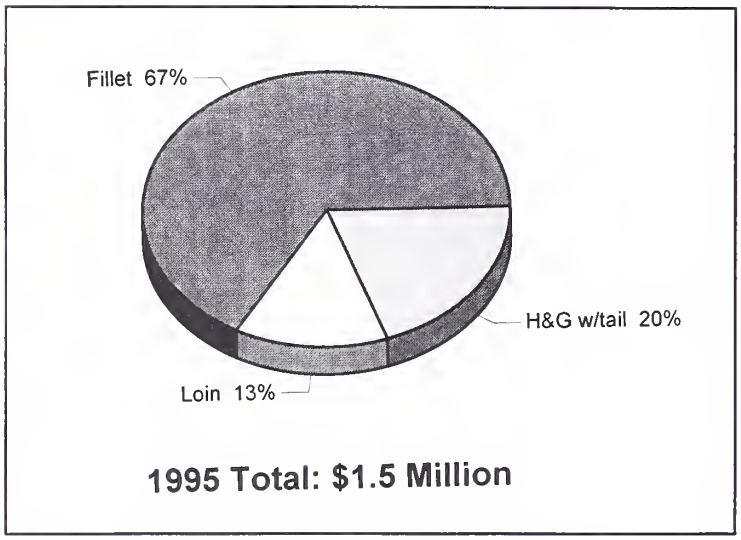

Figure 153.--Most of the frozen exports in 1995 were processed fillets.

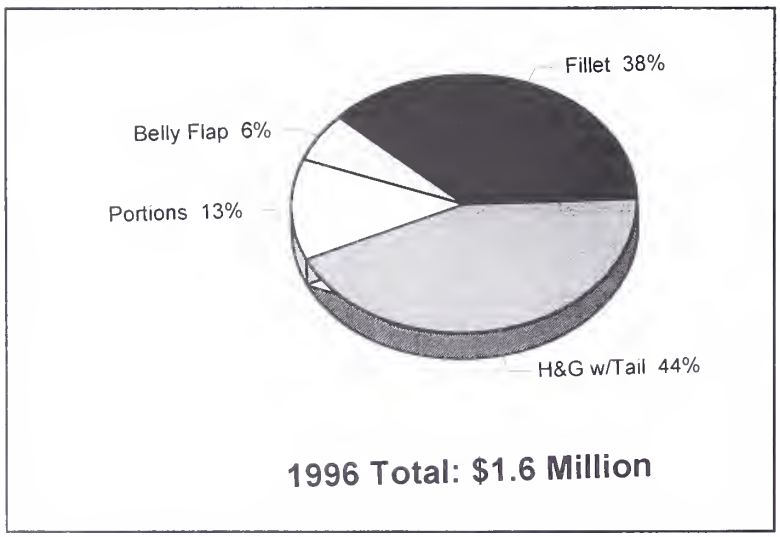

Figure 154.--The product mix of frozen swordfish changed dramatically in 1996 with a major increase in shipments of unprocessed H&G trunks.

XIII. Government Agencies and Policies

A. Agencies

Several Chilean Government agencies have a role in the management of the country's swordfish fishery. In addition to these agencies, several other institutions and universities are involved in swordfish research. (See "Research.")

AM: The Autoridad Marítima (AM) has been working with the fishermen to improve vessel safety. The AM has implemented new regulations requiring more stringent safety measures and improved communication and navigation equipment.[828]

CORFO: The Corporacíon de Fomento (CORFO) is a state corporation created to assist the development of Chilean businesses. CORFO supports industrial and agricultural development efforts. CORFO is also the administrative agency responsible for a variety of development projects sponsored by foreign bilateral and multilateral donor agencies. CORFO during the early 1980s sponsored, for example, an IDB-fisheries development project which promoted the expansion and modernization of Chile's artisanal fleet.[829]

Marina: The Marina (Chilean Navy) is tasked with coast guard as well as military functions. Thus the Marina conducts search and rescue and is also responsible for the enforcement of regulations involving coastal areas, such as pollution and fisheries. The Navy provides, for example, the platforms for at sea enforcement of fishery regulations, but it is not a high priority (photo 135). The Chilean Navy also conducts surveillance operations, including fishing vessels, in the southeastern Pacific, but such surveillance data is classified and not released to the public. The Navy has, however, provided some port call data which provides insights to foreign fishing vessel movements in the southeastern Pacific (appendix D4).

SERNAP/SERNAPESCA: The Servicio Nacional de Pesca (SERNAP or SERNAPESCA) is a unit of the SSP which collects data and implements and enforces fishery regulations issued by the SSP (photo 136). SERNAP has no at sea enforcement platforms and conducts much of its enforcement effort at the principal landing sites. SERNAP also occasionally charters private planes for aerial surveillance (photo 148). SERNAP decided to change its acronym to SERNAPESCA in 1996 to emphasize that it is the Chilean Government agency responsible for regulating fisheries.[830]

SSP/Sub-Pesca: The Sub-Secretaría de Pesca (SSP or Sub-Pesca) is the Chilean fisheries agency within the Ministerio de la Economia which sets fisheries policy and issues the necessary fishing regulations. After some study, for example, the SSP issued swordfish minimum size regulations in 1997.[831]

B. Limits

Chile was one of the first countries to declare a 200-mile zone. Following the U.S. lead, Chile declared jurisdiction over the continental shelf out to 200 miles in 1953.[832] This claim was extended in 1986 to 350-miles around Easter Island and Sala y Gomez Island.[833] The U.S. protested this extension.[834] Chile formally claimed a 120-mile Territorial sea and a 200-mile Exclusive Economic Zone (EEZ) in 1996.[835] Chile negotiated a marine boundary with Peru in 1952. The more difficult marine boundary negotiations with Argentina did not come into force until 1985, after a dispute over three islands in the Beagle Channel and the disputed projection of a marine zone into the

Photo 135.--The Chilean Navy is responsible for providing at-sea platforms for fisheries enforcement. Dennis Weidner.

Photo 136.--SERNAP/SERNAPESCA is Chile's fisheries agency responsible for data collection, enforcement, and other functions. Dennis Weidner.

Atlantic came close to causing hostilities.

C. Promotional efforts

The Chilean Government during the early 1980s promoted the development of new fisheries to help the industry diversify away from its heavy focus on fishmeal reduction. These promotional activities and the energy of Chile's artisanal and commercial sector have been extremely successful. So much so that the focus of the Government has shifted from promotion to management. The Government's promotional efforts have been sharply reduced as the fishermen succeeded in greatly expanding effort. The Government's current focus is on managing developed fisheries to improve yields and prevent overfishing. SPP has found it necessary to sharply curtail fishing effort in many fisheries because of rising pressure on the limited available resource. The swordfish fishery was not a main target of Government promotional efforts, but fishermen benefited from various promotional efforts, especially an IDB-funded project during the mid-1980s to assist artisanal fishermen acquiring improved boats.

Fleet expansion: The Government in the early 1980s sought to assist artisanal fishermen, many of whom had only small open boats, often dangerous to operate on the open ocean. The Government provided low interest credits to enable artisanal fishermen to purchase vessels and acquire modern fishing gear. The credits were provided through a CORFO development project, financed in part by the IDB.[836] This program began in 1983 with credits initially budgeted for $5.5 million, but expanded

Photo 137.--Efforts in the 1980s to expand and modernize the artisanal fleet succeeded beyond expectations and SERNAP now has to limit effort. Dennis Weidner.

to $15.5 million until 1985. The fleet program was soon discontinued because more fishermen than anticipated took advantage of the incentives and, as a result, the fleet expanded beyond all expectations (photo 137). (See: "Fleet.") These credits were for artisanal fishermen in general. Many initially entered demersal fisheries along the central and southern coast, but experienced disappointing yields.[837] Several of these fishermen noted the attractive yields and profitability being reported in the developing new swordfish driftnet fishery. (See "Catch".) As a result, beginning in 1996, many artisanal fishermen decided to rig their new vessels for swordfish driftnetting.[838] (See "Fleet.")

Export promotion: The Chilean Government has actively promoted exports. Exporters qualify for a variety of benefits, including credits for the purchase of Chilean-produced capital goods and duty free imports of equipment needed in the production of export products.[839] The Treasury beginning in 1985 issued processing companies developing non-traditional products 3-10 percent rebates on their exports, until shipments exceeded set amounts.[840] The fisheries producing export-grade fresh product, including swordfish, were all relatively new in Chile (appendix G1c and figure 112), and thus qualified for these incentives. Swordfish fillets and other commodities (custom code 0304.1010) for a brief period qualified for the maximum 10 percent incentive.[841] IFOP offers services to exporters, but the authors know of no special effort to promote swordfish exports.[842]

Research: Chilean research has had a practical focus which has provided useful information to the swordfish fishermen. (See "Research.") IFOP conducted research on longlining and other gear and methods employed in the swordfish fishery. Initially the focus was primarily on tunas. Chilean universities have played an important role in helping fishermen to use satellite imagery to locate prospective fishing grounds.[843]

D. Regulations

The SSP began regulating the swordfish fishery in 1990 because of the rapid expansion of the fleet and growing fishing effort. The primary approach of the regulatory program has been restrictions on fishing effort to prevent overfishing. Thus the SSP is concerned not only with managing the fishery for optimal yields, but also with allocating fish among user groups (artisanal and commercial fishermen). The SSP has also sought to protect the interests of artisanal fishermen who initiated the fishery as part of its overall social policy. For that reason, many Chilean regulations (entry, gear, vessels, and grounds) differentiate between artisanal and commercial fishermen.[844]

The SSP has issued an extensive body of regulations affecting the swordfish fishery. They continued to be concerned about the declining yields and fish sizes and the current management regime significantly restricts fishing effort. The primary regulation governing the swordfish fishery is Decreto N°293, October 15, 1990. The Decree established the basic regulatory regime, specifying fishing areas, type of vessel, and fishing methods. Many of the specific elements have been subsequently modified. The SSP, for example, closed the swordfish fishery to new entrants in 1991. The latest action was a 1997 regulation setting minimum sizes.[845]

The current Chilean swordfish regulatory regime is as follows:

Species: The principal focus of the regulatory regime is swordfish which is the principal target species of both the artisanal driftnet and commercial longline fishermen. The regulations, however, include provisions for by-catches, including tunas (*Thunnus spp.* and *Gasterochisma spp.*), marlins (*Tetrapturus*), and other billfish (*Istiophorus spp.* and *Makaira spp.*). (See "By-catch.")

Vessel: The regulations defined artisanal vessels as those less than 28 m and commercial vessels as those of 28 m or larger. This is significant as gear and fishing areas are different for the two categories.[846] Current fishermen are not allowed to expand effort by adding additional vessels.

New entrants: The SSP prohibits new entrants in both the artisanal and commercial swordfish fisheries as the fishery is fully exploited ("plena explotación").[847] In addition, existing participants are not allowed to acquire larger vessels.

Area: Many artisanal operations are restricted to the Region in which the vessel is based.[848] Chilean regulations make an exception for swordfish because of the migratory nature of the species. Artisanal fishermen (with vessels less than 28 m) targeting swordfish, however, can fish anywhere within the Chilean Territorial Sea and 200-mile EEZ in Regions I-X.[849] Commercial fishing vessels (those totaling or exceeding 28 m) targeting swordfish are prohibited from fishing within a 120-mile/192 km coastal zone. There is no limitation on artisanal fishing beyond the zone, but the limited range of most artisanal vessels preclude such distant offshore operations.

Effort: There are no limitations on the number of swordfish which can be taken or the number and length of fishing trips, but the take is limited indirectly by restrictions on new entrants, gear, and most recently fish sizes.

Gear: SERNAP has set the following gear requirements:

Harpoon: There are currently no regulations on harpoons, but the migratory and seasonal nature of the fish establishes a natural closed season because the harpoon fishermen can only target the fish during the warmer months at the beginning of the year when the fish are more frequently found at the surface and closer to the coast. The low yields and arduous conditions have reduced directed harpooning to minimal levels.

Driftnets: Artisanal driftnets ("red de pared/enmalle") are limited to a length of 2.47 km, measured along the main or upper float line ("relinga de flotadores"), which is submerged about 10-40 meters). The maximum surface area of artisanal nets is limited to 25,000 square fathoms (83.7 square kilometers). Commercial vessels (28 m or more) can have nets up to 37,500 square fathoms (125.6 square kilometers). The surface area is measured by multiplying the length of the float line by the vertical drop of the net side line ("relinga de caisa").[850]

Longlines: SERNAP also limits the number of hooks and line length in the longline fishery. The artisanal vessels (under 28 m) are limited to 1,200 hooks, but commercial vessels (28 m or larger) can have up to 2,000 hooks.[851]

Pelagic driftnets: Chile in 1994 promulgated Protocol II of the international convention prohibiting the use of large-scale pelagic driftnets.[852] The Chilean regulations establish about the same length limit (2.47 km) as the U.N. Resolution (2.5 km). The U.N. Resolution, however, only pertains to fishing in international waters.

Season: The harpoon fishery off the northern coast near Peru was restricted to March through May until 1984. There are now no seasonal limits, but the availability of fish limits most fishermen to operations during only a few months of the year, especially early in the season.

Size: Chilean officials have been assessing for several years the need to impose size restrictions. Chile until 1997 has no swordfish size limit and fishermen, especially the commercial longline fishermen, were taking some very small fish. The longline fishermen in some months averaged fish of only 17-20 kg, meaning that over half of the individuals were smaller than 20 kg (appendix B5g3 and figure 29). Some Chilean companies in 1996 expressed concern that the SSP was considering a minimum size of 58-kilograms. The 58 kg size was reportedly based on a study by a Chilean biologist concluding that fish of that size have matured to a point that they have had a chance to spawn at least once. Such a size limitation would have a major impact on the longline fishery which reports that more than half its catch is less than 58 kilograms.[853] Available data confirms that a very substantial part of the longline catch is under 58 kg (appendices B5g1 and B5g3 and figures 29 and 47). This is especially critical given that most of the catch was taken by the commercial longliners in 1996, although the size distribution is unavailable. The SSP after assessing the state of the resource issued minimum size requirements in 1997. The minimum acceptable size was set at 106 cm, measured from the front of the base of the first dorsal fin to the back of the second dorsal fin. The SSP estimates the length from the lower mandible to the tail fork ("horquilla") would be about 184 centimeters. The SSP also estimates that this would correspond to fish about 76 kg (live weight) which would mean trunks of about 58 kilograms.[854] This would be a relatively strict minimum-size standard, much lower for example than ICCAT standards in the Atlantic.[855] It may have a significant impact on Chilean commercial longline operations and many commercial fishermen expressed their concern to the authors on the impact of minimum size regulations. The fishermen were clearly taking many small fish.[856] A by-catch of 20 percent juvenile fish is allowed and special allowances are set for artisanal fishermen landing small numbers of fish who can retain 2 small fish even if they catch less than 10 fish in total.[857]

Cooperation: Chilean swordfish vessels are required to provide SERNAP fishing data and to carry an observer, if requested.[858]

Fines: Fines for violation of the regulations were modified in 1995 to total about $4,900 per ton of fish.[859] The fines were raised again in 1997.[860] The fines for illegally caught swordfish are some of the most severe set by the SSP. The fine was increased to 112.2 unidades tributarios mensuales (UTMs) per ton of swordfish. Only puye, salmon, and marine mammals and birds have higher fines.[861]

Chilean fishery managers have opted for a traditional approach to swordfish management. The SSP during the early 1990s restricted effort and in 1997 issued minimum size restrictions. These regulations are similar to regulations recommended by ICCAT in Atlantic fisheries and major fishing countries such as the United States, Canada, Spain , Japan, and others.[862] Some fishery biologists are recommending a controversial new approach. They suggest that given the relatively high natural mortality of juveniles, that the fishermen should be allowed to take the small sizes, but the take of large adult spawners should be restricted. This approach has been debated at recent ICCAT meetings.

The swordfish regulatory regime is highly controversial. The fishermen, like fishermen in other countries, are generally wary of Government restrictions on fishing effort. Both principal user groups are highly critical of each other. In addition to criticizing each other, both groups are critical of foreign fishermen who many Chileans believe are the principal culprit causing the catch decline since 1991.[863]

Artisanal fishermen: A representative of the artisanal fishermen expressed concerns in early 1996 that they were finding it increasingly difficult to compete.[864] Those concerns were born out as the fishery progressed and the artisanal catch fell to extremely low levels (appendix E2f and figure 64). The small-scale driftnet fishermen accuse the longline fishermen of taking small fish before they can spawn. They are convinced that this has had a major detrimental impact on stocks. They complain that the fishery is now being conducted primarily on offshore grounds where their vessels can not reach.[865] (See: "Species: Year class.") The artisanal fishermen claim that their gear is much more selective in terms of avoiding the catch of small, juvenile swordfish.

Commercial fishermen: Company officials are concerned about the limits placed during 1997 on the size of fish which can be harvested. One union official, while agreeing with the need to protect the species, also worried about unemployment among workers. He is also concerned that placing limits on the size of the individuals taken could effectively close down the commercial longline fishery.[866] The longline fishermen insist that their take of small fish has been over emphasized and that in fact it may be better to protect adult spawners rather than immature fish which are subject to extensive natural mortality. The commercial fishermen contend that there is, in fact, an implicit restriction on taking small fish regardless of government regulations. The low prices for small fish makes them unprofitable to catch. The longline fishermen charge that there is a much more serious by-catch problem with the driftnet fishery than commonly acknowledged.[867] They charge that driftnets are much less selective than longlines and take a host of non-targeted species, including turtles, birds, marine mammals, and other fish. In addition none of the driftnet by-catch is generally landed alive. The longliners indicate that they are able to release some of their limited by-catch before it dies.[868] (See "By-catch.") They also point out that they do not fish in coastal waters and if the swordfish have been fished out along the coast, the artisanal fishermen who fish there must be, at least, partially responsible.

XIV. Research

Considerable swordfish research is underway in Chile. Chilean researchers are pursuing a variety of studies, including sampling landings, determining ages, assessing growth rates, investigating stomach contents, assessing the impact of grounds and gear, measuring gonads, correlating fishing results with water temperature and color, and a variety of other subjects. In addition, researchers are cooperating with foreign researchers on these and other topics, including genetics. Detailed data, however, is only available since 1992 and IFOP believes this is inadequate for a valid stock assessment.[869]

CEE: The Centro de estudios Espaciales (CEE) was established in 1960. The Centro serves as a satellite tracking station for various foreign countries (China, Japan, and the United States) to help maintain the satellites. CEE was, for example, part of the U.S. National Aeronautical and Space Agency's (NASA's) satellite tracking net until 1989. CEE's satellite tracking station has the capability of downloading the data transmitted by the satellites, including NOAA satellites. They use this capability to produce charts for interested Chilean government agencies, research institutes, and companies. One of their projects (SATAL) involves using data from NOAA satellite 12 and 14 to produce sea surface temperature charts through a grant provide by Canada's CIID. Two university groups, the Escuela de Ciencias del Mar at UCV and the Centro de Estudios Espaciales at UC, use the data from CEE (figure 89) to produce temperature charts for the fishermen (figure 90) as part of a project begun in 1986. The data is used by the fishing industry as well as companies and individuals in other areas such as agriculture.[870]

FIPA: The Fondo de Investigación Pesquera (FIPA) is a government-foundation created to finance fisheries research. FIPA, beginning in 1994, has financed work on swordfish, in part because of concern over the sharply reduced catch. FIPA approved a swordfish research project for IFOP, "FIPA Monitoreo de la pesquería del recurso del pez espada (I-X Regions)."

IFOP: The Instituto de Fomento Pesquero (IFOP) is one of the premier fisheries research institutes in Latin America. IFOP is a semi-autonomous unit of the SSP. IFOP conducts fisheries research, but its funding is not guaranteed. It has to compete with university institutes and private research groups for contracts--even FIPA and SSP contracts. IFOP also works cooperatively with various Chilean universities. IFOP has established swordfish as one of its research priorities, in part because of the huge catch declines in recent years and desire by the Sub-Secretaría de Pesca to better manage

Photo 137A.--IFOP researcher Miguel Donoso preparing samples aboard an artisanal fishing vessel. IFOP

the species. Much of the Chilean research mentioned in this book is conducted or at least coordinated by IFOP. (See "Research.") IFOP and associated university scientists have collected considerable information on swordfish, including port and at sea sampling.[871] Fishermen submit detailed statistical reports. IFOP researchers have participated in exploratory cruises as early as the 1970s to determine possible tuna and swordfish catches from longline fisheries.[872] The first assessment was conducted in 1971 off Iquique using a Japanese longliner. Further work was conducted in 1979 with the Japan Marine Fishery Resources Research Center (JAMARC) to assess tuna abundance in Chilean waters. The research effort in the 1970s focused primarily on tuna, but a substantial swordfish by-catch was reported which impressed the researchers because of catches during months when Chilean harpoon fishermen were not taking swordfish. IFOP researchers were also impressed that substantial quantities of swordfish were taken despite setting the gear for tunas.[873] Much of IFOP's research has had a practical focus designed to promote the fishing industry and expand catches. IFOP has, for example, assessed new, more effective gear--such as the use of driftnets and longlines.[874] As the Chilean fishing industry has developed, IFOP's focus is increasingly turning to biological studies designed to collect the data needed for better managing developed fisheries. The SSP in 1989 tasked IFOP with monitoring the swordfish fishery. As a result, IFOP during the 1990s has devoted considerable attention to the species. IFOP's work has included monitoring the swordfish fleet as well as biological studies on swordfish.[875] IFOP since 1990 has been collecting extensive fisheries data (port, grounds, time and place of sets, number and size of fish caught, and effort) from the fleet as well as biological samples from landing sites and aboard fishing vessels.[876] The sharp decline of catches and resulting adverse impact on the fishermen and companies has heightened the need for increased assessments so that the fishery can be better managed. IFOP, in 1994, began a special FIPA project to monitor the swordfish fishery, "FIPA Monitoreo de la pesquería del recurso del pez espada (I-X Regions)." IFOP researchers, as a result, have published a variety of research works and assessments on swordfish.[877] IFOP began a study in 1994 to assess the distribution of catches and yields by ocean area, publishing an especially detailed report with extensive data on fleet operations.[878] IFOP hopes to eventually prepare an extensive stock assessment and has already provided preliminary data to the SSP.[879] IFOP publishes a review of its overall research program annually.[880] IFOP is cooperating with the Southwestern Fisheries Science Center (F/SWC) of the U.S. National Marine Fisheries Service as part of a wider fishery cooperation program initiated in 1995. IFOP and NMFS agreed in 1996 to designate swordfish as a priority in the cooperative research programs currently underway.

IHA: The Instituto Hidrográfico del Armada (IHA) has done extensive hydrographic research on the Humboldt and other oceanic currents.[881] While not

focused on fisheries, their work provides valuable insights for future assessments of the relationship between swordfish distribution and currents.

UC: The Universidad de Chile's (UC) Centro de Estudios Espaciales (CEE-Center for Space Studies) is working with the UCV in its satellite imaging project.[882]

UCN: Researchers at the Universidad Católica del Norte (UCN) in Coquimbo have assessed the use of satellite data to find warm water plumes in the cold upwelled water off Coquimbo in which swordfish could be targeted.[883]

UCSCT: A researcher at Universidad Católica de la Santísima Concepción de Talcahuano (UCSCT) in cooperation with IFOP has done some work on swordfish age and growth rates.[884]

UCV: The Escuela de Ciencias del Mar at the Universidad Católica de Valparaíso (UCV) in 1986 initiated the SATAL project to use satellite imaging for identifying possible fishing grounds for albacore tuna. UCV worked closely with artisanal fishermen at Quintay and Valparaíso on the SATAL project.[885] The UCV has since 1994 been actively preparing SST maps for artisanal fishermen.[886] The images provide sea surface temperature over large ocean areas and have enabled the fishermen to significantly reduce the time needed to identify prospective fishing grounds--thus reducing operating costs and increasing fishing efficiency.[887] As the project developed, the images were found to be useful not just for albacore, but also for swordfish which appears to be more abundant off Chile. The UCV works with CEE through the SATAL Project to provide this satellite imagery to the fishermen. CEE provides the data and UCV converts the data into products which the fishermen can use. The Canadian foreign assistance group, the Center for International Investigation and Development (CIID) has helped fund the research and the purchase of satellite data from CEE.[888] UCV researchers have done some work attempting to identify potential linkages between climatic variables and swordfish abundance and distribution.[889]

Various companies: Some companies, such as Pesquera Catalina and Pesquera Atún Mar, have helped introduce modern fishing gear and handling methods to the fishermen. Foreigners have played an important role in several of these companies. Other Chilean companies have conducted research on swordfish, primarily technical work on gear and methods. Little of that work, however, has been published.[890] Other companies, such as Pesquera Santa Lucía, have cooperated with IFOP and university researchers on various studies.

Some of the earliest work on Chilean swordfish has been conducted in cooperation with foreign researchers. Japanese and United States researchers have played a particularly prominent role:

Canada: The Canadian Center for International Investigation and Development (CIID) has supported the UCV with its work on satellite imaging, cooperating on the SATAL II Project.[891]

Japan: Chilean researchers used a Japanese longliner in 1971 to test fish for tuna and swordfish.[892] The Japan Marine Fisheries Resource Research Center (JAMARC) assisted in test fishing during 1979 for longline gear.[893]

United States: The University of Miami in cooperation with the Chilean Government and various companies conducted an assessment of large pelagic stocks, including swordfish, off Chile during 1956-57. This is the first scientific assessment of the resource known to the authors. Test fishing using harpoons, lines ("curricánes"), and longlines were used in the area around Valparaíso and the Juan Fernández Islands. Fishermen from Iquique participated in the project. The researchers led by John Manning found that swordfish were concentrated off the northern coast (Taltal to Caldera), but to the surprise of the Chileans also found fish along the central coast. The U.S. researchers speculated that high winds during the peak fishing season may make recreational fishing difficult, but there was an excellent potential for commercial fishing.[894] The National Marine Fisheries Service (NMFS) Southwestern Fisheries Science Center (F/SWC) in La Jolla, California and the F/SWC Laboratory in Honolulu, Hawaii are working on Pacific swordfish. NMFS and IFOP in 1996 agreed to work cooperatively and designated swordfish work as one of two priority subjects. An IFOP researcher in 1996 participated on a F/SWC swordfish research cruise aboard the NOAA *R/V Townsend Cromwell* on grounds north of the Hawaiian Islands. The IFOP researcher worked with F/SWC specialists on field observations, collecting tissue and organ samples, acquiring and initial processing of oceanographic data for assessments of swordfish habitat, as well as other research operations. Informal discussions have been held on possible south Pacific cruises.[895]

Chilean biologists have reported a variety of problems in their current swordfish research.

Scarce berths: Chilean researchers have had difficulty obtaining berths on artisanal and commercial vessels. The small size of the artisanal vessels makes many fishermen unwilling to take on researchers. The owners have to be concerned primarily with efficiently operating the vessel, and accommodating non-crew members can be a problem.

Cramped vessels: Even if researchers are able to arrange for berths, the cramped quarters make it difficult to measure the fish. There is also little room which can be used to preserve samples.

Inadequate training: Few Chilean fishermen are trained in sampling techniques so the available data is limited to the limited number of studies conducted by IFOP and university researchers.[896] IFOP and other researchers are attempting to work with the fishermen in sampling techniques (taking measurements, sexing the fish, etc.) in an effort to widen the coverage of sampling studies.

Declining catch: The declining catch since 1991 has further complicated the task of obtaining samples as Chilean fishing effort has been significantly reduced.

Consumed samples: Researchers are especially interested in acquiring gonads for further maturation studies. The fishermen are, however, reportedly often uncooperative. Many are unwilling to give up the gonads. Apparently they are eaten at sea by the fishermen who find them a tasty delicacy.[897]

XV. By-catch

The authors know of no Chilean study assessing the by-catch in the Chilean swordfish fishery. Some preliminary reports, however, suggest that the impact, especially on turtles, may be significant. The Chilean research effort has focused primarily on collecting data on swordfish itself so that it can be better managed. (See "Research.") Little attention has been given to assessing the by-catch of either the artisanal driftnet or the commercial longline fishermen. The authors have, however, collected a few anecdotal accounts by government officials and the fishermen as well as preliminary reports by environmental groups. This has proved to be an especially difficult chapter to research. Not only is Chilean data limited, but many Chilean companies are aware that U.S. law and litigation by environmental groups have resulted in trade actions concerning the environmental impact of specific fisheries such as the tuna and shrimp fisheries. Several companies were, as a result, reluctant to discuss by-catch issues with U.S. Government officials. The authors have included information from other Pacific fisheries to provide possible insights as to what may be happening in Chile.

Tuna: Chilean fishermen report a small tuna by-catch which accounts for about 5 percent of the longline catch. There are also some tuna (mostly butterfly tuna, *Gasterochisma melampus*) taken by driftnets, but one observer reports that this rare.[898] Chile reports very small tuna catches (appendix K2 and figure 155).[899] Much of this small tuna catch is taken as a by-catch of

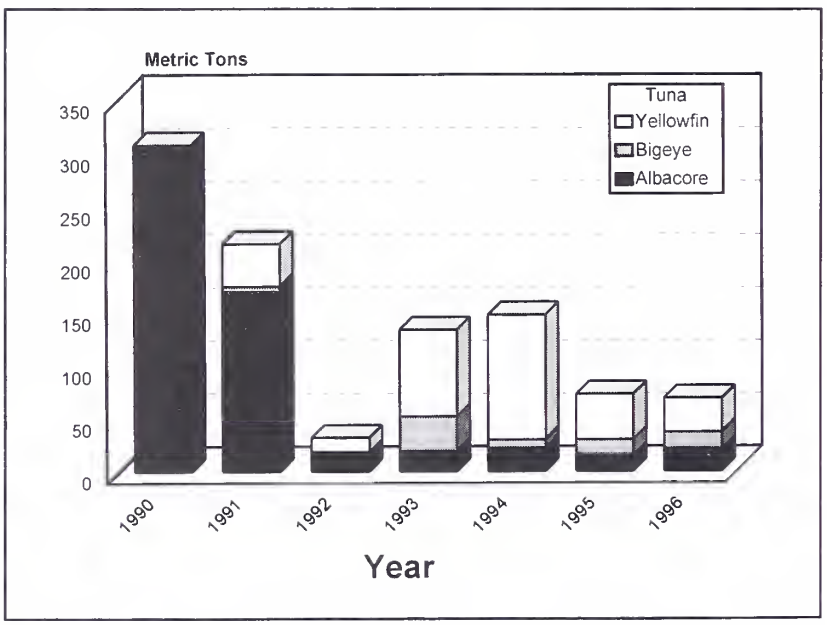

Figure 155.--Chile's longline fishery reports only minor tuna catches and the species mix has varied substantially from year to year.

the swordfish longline fishery.[900] Notably the tuna catch did not increase in 1996, despite the substantially increased swordfish longline catch. The tuna (albacore, bigeye, and yellowfin) by-catch is limited for two primary reasons. First, the Spanish-style longline methods used by the commercial longliners set the hooks at relatively shallow depths, commonly 35-55 m) (appendix D1b and figure 84). Tuna is apparently more abundant in deeper waters.[901] Second, several tuna species have a generally tropical/subtropical distribution and, as a result, are less abundant off Chile than off Peru and Ecuador to the north.[902]

Billfish: Billfish are known to occur off northern Chile. Foreign recreational fishermen reported "finning" marlin (presumably black marlin) off northern Chile during the 1940s and 50s.[903] Data on incidental billfish catches are unavailable. Billfish are known to be taken by Chilean longliners (photo 138). Foreign longline fishermen have reported substantial billfish catches in the waters north and west of the Chilean EEZ.[904] As the Chilean fishermen increasingly move into offshore waters they will presumably report billfish by-catches comparable to the foreign fishermen, especially the Spanish fishermen who also target swordfish. SERNAP publishes some longline by-catch data provide by the fishermen. The data shows erratic marlin (SERNAP identifies them as stripped marlin) catches (appendix K1). One researcher reports that sailfish are occasionally taken.[905] Billfish have a generally tropical/subtropical distribution and, as a result, are less abundant off Chile than off Peru and Ecuador to the north.[906] U.S. (California) driftnet fishermen report a substantial billfish by-catch.[907] Any billfish by-catch by the Chilean driftnetters is probably substantially less because billfish primarily occur off Chile's northern coast where there is little driftnetting.[908] Most of the Chilean driftnets are deployed off the central coast. (See "Fishing Grounds".)

Shark: Sharks were not a species normally taken by traditional Chilean fishermen, many of whom reportedly had a loathing for the animals and referred to them as "swordfish with teeth" ("albacora con dientes").[909] Sharks are, however, the principal by-catch taken in the modern swordfish fishery. Some data is available from the longline fishery conducted outside the 200-mile zone suggesting that most of the shark by-catch is makos ("marrajo"), although some blues are also reported (appendix K1 and photo 139). Some of this data is difficult to evaluate as it is probably only refers to the sharks retained. This probably explains why the quantity of the 1996 shark by-catch did not increase despite the expanded swordfish catch (appendix K1 and figures 156-157). One company operating longliners reports that the quantity of makos taken varied from 1-6 t per trip, compared to the 20-30 t of swordfish usually

Photo 138.--Billfish like this marlin are taken as by-catch by Chilean longliners. Sebastian Vera.

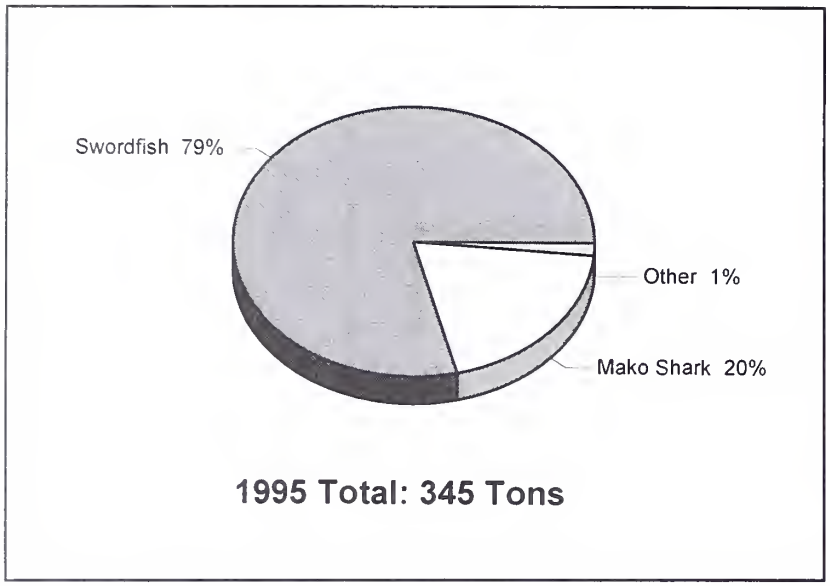

Figure 156.--The primary by-catch reported by Chilean longline fishermen in international waters is shark.

taken.[910] Apparently the Chilean fishermen after finning hooked sharks, only retain the makos. Company and SERNAP officials familiar with the driftnet fishery report that sharks, mostly small individuals, are also the principal by-catch of the artisanal fishermen. Makos are the principal species, although some blues and occasional threshers are also caught and discarded.[911] Some problems are reported as a result of damage by sharks to the longline catch before it can be harvested. (See "Processing and Products".)

Cetaceans: A variety of cetaceans occur off Chile. The limited time frame of this report does not permit an assessment of the many different species, but Chilean authors have published several inventories and observations along the central coast.[912] There are some reported interactions between swordfish fishermen and various cetaceans. One Chilean observer reports "occasional mortalities" in the driftnets set by Chilean swordfish fishermen. Mortalities have been reported of Liso dolphin (*Lissodelphis peroni*), sperm whales (*Physeter macrocephalus*), pilot whales (*Globicephala sp.*), beaked whales (*Ziphiidae sp.*), killer whales (*Orcinus orca*), and roqual whales (*Balaenoptera sp.*)[913] Details on the frequency of the interactions are not available. Dolphins off Chile have been reported picking off the longline bait, but they apparently do not take the hooks.[914] Chilean fishermen have, however, not reported interactions with cetaceans in conversations with the authors, but for the most part were reluctant to discuss the subject. The authors know of no statistical data on small cetacean by-catches from the driftnet or longline fishery. Information available for the western Pacific suggests cetacean interactions with longlines are unusual, although occasional dolphin by-catches have been reported.[915] U.S. (Hawaii) longline fishermen report significant interactions with cetaceans, but few mortalities.[916] U.S. (California) driftnet fishermen report taking a wide variety of cetaceans.[917] The incidence of U.S. cetacean by-catches were relatively low, but could be significant for large numbers of vessels operating for an extended period. The decline of the Chilean swordfish driftnet fishery since 1991 has certainly lowered any cetacean by-catch.

Pinnipeds: Four species of pinnipeds are commonly found off Chile. There are three species of fur seals, Antarctic fur seal (*Arctocephalus gazella*), the Juan Fernández fur seal (*A. philippii*), and the southern fur seal (*A. australis*) and one sea lion (*Otaria flavescens/byronia*). The range of Antarctic fur seals appears to be well south of the area where swordfish are common.[918] As a result, they probably do not come into contact with Chilean swordfish fishermen.

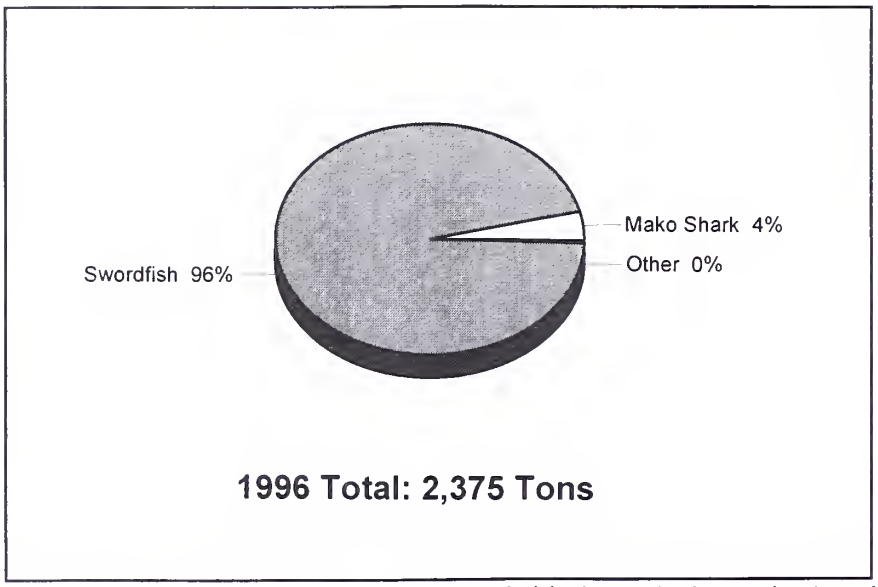

Figure 157.--Chilean longline fishermen in 1996 reported minimal by-catches in operations beyond Chile's 200-mile limit.

Photo 139.--Much of the shark catch is found and then discarded, but the makos are generally retained. Sebastian Vera.

The range of the southern fur seal rarely extends north of Chiloé Island.[919] Thus interactions with swordfish fishermen would also be very rare. Fishery interactions with Juan Fernández fur seals and sea lions appear the most likely.[920] This is especially true because some commercial longliners during 1996-97 have reported substantial catches off the Juan Fernández Islands. (See "Catch".) The population of sea lions is particularly large and the species occurs all along the northern and central coast. Artisanal fishermen in Region V and other areas have reported serious interactions with pinnipeds, primarily sea lions. The artisanal fishermen targeting groundfish in inshore waters have been particularly affected and complain that pinniped populations have been growing (photo 140). Interactions with salmon farmers whose pens are very close to shore have also been reported. The artisanal fishermen estimate that 800,000 sea lions inhabit Region V alone.[921] These interactions, however,

Photo 140.--Sea lions can disrupt fishing operations and destroy gear. As they are protected in Chile, many will frequent even populated ports. Dennis Weidner.

appear to be less common for the swordfish fishermen who operate further offshore. One university researcher reports that because seals and sea lions are largely coastal, there are no interactions with the swordfish fishermen. This may be especially true because the fishermen are gradually moving their operations further and further off the coast.[922] The artisanal fishermen report that seals are not entangled in the driftnets, but some fishermen occasionally complain that pinnipeds sometimes feed on the catch.[923] Thus there may be some entanglements. Pinnipeds are known to be taken as a by-catch by U.S. (California) driftnet fishermen. The level of by-catch varies, but in some years has been significant.[924] Virtually no information is available on foreign interactions, but based on an assessment of western Pacific fisheries, interactions may be rare.[925] U.S. (Hawaii) longline fishermen do not report mortalities, although there are sometimes animals sighted in the area of the gear. Results may have been affected by the small pinniped population in Hawaii.[926]

Turtles: Researchers report that five species of turtles are found in the southeastern Pacific and four as far south as Chile. The four species found off Chile include: green "verde" (*Chelonia mydas agassizi*), leatherbacks "laud" (*Dermochelys coriacea*), olive Ridleys "olivacea" (*Lepidochelys olivacea*), and to a more limited extent loggerheads "boba" (*Careta careta*). Chilean fishermen report that turtle interactions are limited. There are some natural limitations on turtle abundance off Chile as a result of the country's southern latitudes and the climatic impact of the cold Humboldt current.[927] One turtle expert points out, however, that leatherbacks in particular have a range extending to southern latitudes. Turtles do clearly occur off Chile and foraging grounds off the country may be important for some species. Leatherbacks have been observed over the entire range of the Chilean swordfish fishery, as far south as Chiloe Island (42°S) throughout the year. Green turtles have been observed even further south.[928] Turtle experts explain that while the estimates "for incidental catches are not large, the impact on some turtle stocks may be important."[929] Data on actual interactions is very limited (photo 141).[930] Biologists are, however, especially concerned about endangered leatherbacks.[931] Leatherback nestings throughout the Pacific have reached critically low levels.[932] Leatherbacks from Mexican beaches fitted with radio transmitters in 1997 are being tracked moving due south past the Galápagos and, after 6 months, approaching latitudes off Peru (Peru, figure 30).[933] Chilean researchers have reported leatherbacks tagged at both Costa Rican and Mexican beaches.[934] When completed, the tracking will presumably show details of the migratory route into Chilean waters, although the 1997 track may be affected by the powerful developing El Niño event.[935] Chilean observers differ somewhat on interactions with turtles. Most fishery officials and fishermen report that turtle interactions are negligible or non-existent. This is probably because turtle interactions are rare and a minor part of the annual operations on any single vessel. A SERNAP official indicated that he has heard of turtles taken in the fishery.[936] One university researcher reports that he has observed no interactions with turtles, but notes colleagues had noted very small numbers of turtles, mostly leatherbacks.[937] Various company officials associated with both driftnets and longlines report that they do not take any turtles off Chile.[938] Other observers assessing the artisanal driftnet fishery, however, report substantial mortalities. Turtle biologists are increasingly concerned over the impact of fisheries on turtles.[939] Researchers

Photo 141.--Mexican officials are concerned that their efforts to protect turtle nesting beaches may be impaired by expanding longline fisheries. Dennis Weidner.

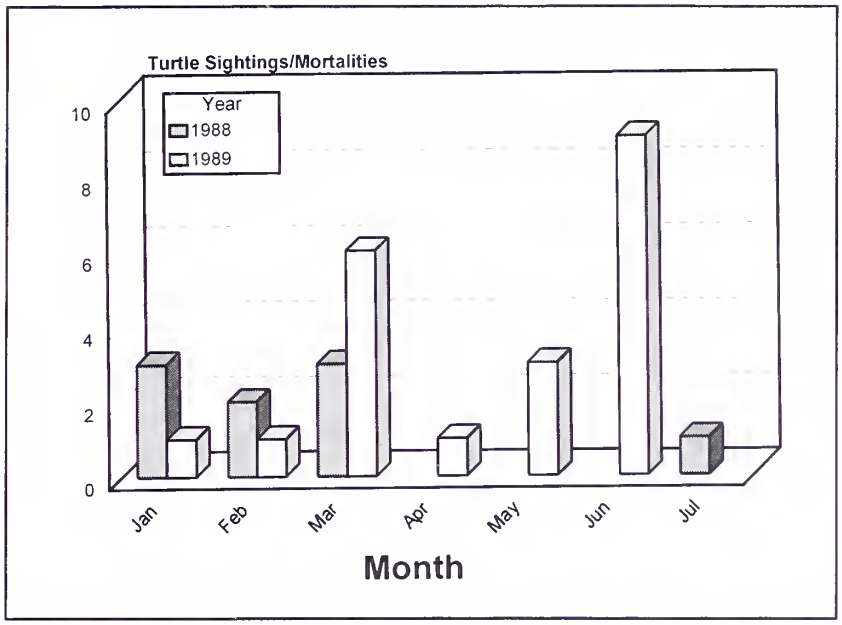

Figure 158.--One report in the late 1980s suggested that even a single Chilean driftnet vessel can have significant turtle interactions.

studying leatherbacks are worried over the plummeting numbers of nesting females and are attempting to determine the cause. One researcher notes that the development of the swordfish fishery in Chile appears to corresponds with the decline of the leatherback population.[940]

Driftnets: Given the size of the swordfish driftnet fleet in the early 1990s, even minimal interactions might have caused several hundred turtles mortalities annually. Two researchers specializing in turtles have noted substantial interactions with the artisanal driftnet fishermen, primarily with leatherbacks and a few greens (appendix K3a and figure 158).[941] Chilean researchers have also noted olive Ridleys and a few loggerheads.[942] One observer reports that turtles began appearing in Chilean markets in 1987, just as the swordfish driftnet fishery was expanding and the swordfish driftnet fishery may be one of the reasons for the substantial decline of the population noted in recent years.[943] (See "Catch".) One fisherman who worked on swordfish vessels estimates that the Chilean artisanal swordfish fishery at its peak when several hundred vessels were operating may been taking several hundred turtles annually.[944] Another observer believes that the catch has been primarily leatherbacks (appendix K3b and figure 159). He concluded that the driftnets are "very harmful to turtles".[945] Chilean observers report that it has proven extremely difficult to determine the impact of the driftnet fishery because the fishermen have had to move increasingly off shore in recent years making it more difficult to assess the fishery. Chilean observers, however, report that mortalities can be significant. Observers have reported occasional individual sets with leatherbacks mortalities of from 3-13.[946] A comparable fishery, the U.S. (California) driftnet fishermen report minimal turtle mortalities.[947] Mexican officials also report minimal turtle mortalities in their neighboring swordfish driftnet fishery. The low United States-Mexican mortalities may in part be because the fisheries are conducted along northern Baja/southern California, away from the important turtle nesting beaches.[948] The Museo Municipal de Ciencias Naturales y Arqueología de San Antonio has initiated a project to monitor entanglements. The project includes efforts to work with the fishermen to encourage them to release turtles retrieved live and even resuscitate individuals if necessary.[949] Museum officials tagged two entangled olive Ridleys in 1995. A few turtles tagged in Mexico and Costa Rica have been taken by purse seines, driftnets, and other gear.[950] Recent trends may be affecting turtle interactions, but the impact has not been fully assessed.

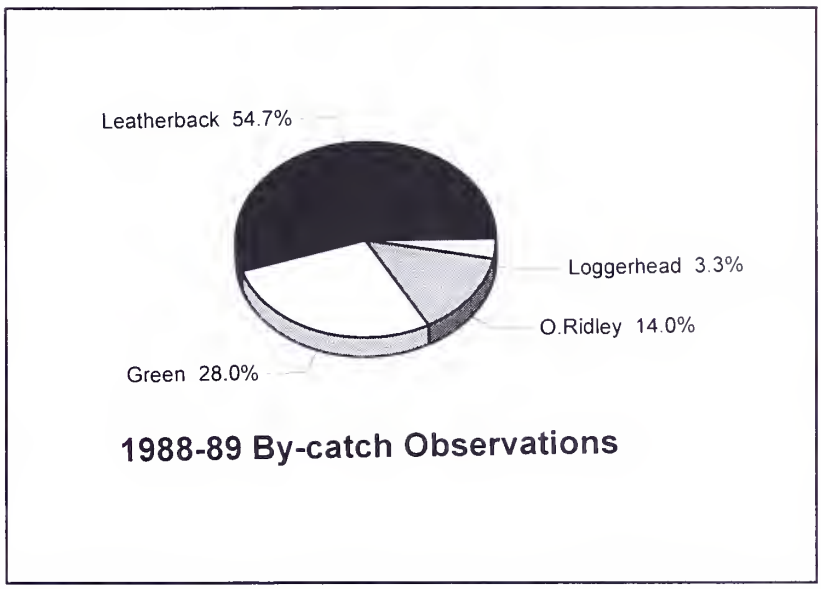

Figure 159.--One observer reported during the late 1980s that leatherbacks were the principal turtle taken in the swordfish driftnet fishery.

Current interactions with leatherbacks, for example, may now in fact be quite low because the population has been so badly depleted. Given the decline in the artisanal swordfish fishery and the withdrawal of many vessels, the incidental turtle catch, especially along the coast, probably has declined sharply. (See "Fleet".)

Longline: The turtle by-catch of the longline fishery may also be of some importance. Chilean fishermen indicate that they are not taking significant numbers of turtles as a by-catch. The authors, however, know of no independent collaborating data off Chile. Chilean researchers report that there are mortalities of leatherbacks and greens from the longline fishery, although probably less than from the driftnet fishery.[951] Some data is available in other Pacific fisheries. One study suggests that foreign longline fishermen in the western Pacific seldom or rarely take turtles and do not retain them.[952] Ecuadorean officials, however, report seizing turtle skins aboard Japanese longliners.[953] U.S. (Hawaii) longline fishermen report turtle interactions, although relatively few mortalities.[954] Several reports have confirmed mortalities from tuna/swordfish longline fisheries conducted by Asian and United States fishermen.[955] The mortalities from the Asian longliners are the most significant because of the substantial effort deployed. The full impact is not well documented. Researchers estimate, however, that the levels of incidental capture and mortality are high enough to affect recovery of threatened and endangered species.[956] Given the substantial, expansion of Chilean longline fishing in offshore areas during 1996, the potential impact on turtles, especially critically endangered leatherbacks is a subject of some interest.

Other fisheries: The swordfish fishery is not the only fishery which may have affected turtles. One local observer reports that turtles generally do not come close to the coast, thus there may be only limited interactions with the country's substantial purse seine fleet.[957] The purse seine fishery, however, in recent years has shifted from a reliance on coastal anchovy and sardines to a massive take of jack mackerel further from the coast where turtle interactions may be more common.

Other: The driftnet fishermen report taking a variety of other species, including moonfish or opah (*Lampris regius/guttatus*) and others.[958]

Interactions with marine mammals appear limited. Chilean swordfish fishermen, unlike Atlantic-coast fishermen, do not report extensive problems with killer whales. One researcher reports no interactions with killer whales.[959] Some company representatives report scattered incidents with killer whales, emphasizing that they are very rare.[960] One company official reported two incidents with killer whales damaging the catch. In one of these incidents the killer whales ate the stomachs of one species of shark ("quella") that had been taken, leaving the carcass and other species untouched.[961] He noted that more serious problems with killer whales have been reported around the Juan Fernández Islands (33°S, 79-80°W). As a result the company avoids fishing in that area.[962] Two fishermen have reported problems with a solitary killer whale in 1996 in operations between Robinson Crusoe and Alejandro Selkirk Islands (33°S, 80°W) was observed at the *Brisca*'s bow. The whale would eat the posterior fins of sharks taken on the longline, but did not bother the rest of the catch.[963] This behavior is strikingly different than that reported by Latin American fishermen in the Atlantic.[964] Another company operating longliners reports that they have experienced more problems with killer whales and other marine mammals interfering in the Chilean (Pacific-coast) fishery for Patagonian toothfish.[965]

XVI. International

Chilean international fishery relations are more complex than many other Latin American countries as there are both foreign fishermen and companies desiring to participate in the Chilean fishery as well as Chilean companies deploying vessels on the highseas and out of foreign ports.

A. International relations

1. Bilateral

Chile has extensive international fishery relations with foreign countries. One of Chile's primary international concerns is foreign fishing. Chile was the first country to declare a 200-mile fishing zone, primarily out of concern over foreign whalers. In more recent years, the Chilean Government has faced extensive foreign fishing in the southeastern Pacific, especially the massive Soviet/Russian effort conducted until 1991-92.[966] Chile has strictly limited foreign fishing in its 200-mile zone. The Chilean Government until 1991 issued a few licenses to foreign companies (Korean, Japanese, and Spanish vessels) conducting operations (through joint ventures, affiliates, etc.)--mostly off the southern coast. The foreign companies were required to register their vessels in Chile. A new law passed in 1990 discontinued the issuance of new permits to foreign fishermen.[967] Foreign companies with valid licenses, however, were allowed to continue operating in Chile.[968]

Various Chilean observers have reported extensive foreign longline activity outside the Chilean 200-mile limit. Several countries appear to be involved. The largest effort is conducted by the Japanese, but this is a multi-species fishery and swordfish is not the principal target species. Unidentified foreign owners also operate longliners under the Honduran and Panamanian flags. Again these are multi-species fisheries. The largest directed swordfish operation is conducted by the Spanish, but effort has varied substantially in recent years. A few U.S. longliners have also occasionally operated off Chile. Some of these fishermen, mainly the Japanese, transship at sea, but other transship their tuna catch through the Chilean port of Arica (photo 142). The Japanese also transship some of their tuna through Arica. The Spanish, are also transshipping their catch, primarily swordfish, through Peruvian ports. (See "Transshipping.") One observer estimates that as many as 40 Spanish vessels were involved in the fishery during the early 1990s.[969] Chilean fishermen and companies are highly critical of the foreign fishing effort off Chile. Many are convinced that the foreign fishing, especially

Photo 142.--Foreign fishermen can transship through Arica, but not species like swordfish targeted by Chilean fishermen. Dennis Weidner.

the Spanish fishing on the Nazca Ridge, where many juveniles are taken, is adversely affecting the Chilean catch.[970] (See "Species: Stock status".) The level of foreign activity, however, appears to have declined sharply in recent years (appendix E5 and figure 19).

Bilateral relations concerning swordfish with individual countries are as follows:

Honduras: Chilean officials report that Honduran vessels are transshipping tuna through Arica (appendix D4).[971] (See "Transshipments.") The longliners involved are presumably operated as flag-of-convenience vessels. The actual nationality of the vessels is unknown, but they appear to be primarily operated by Taiwan owners.[972] Chilean officials confirm that the crews are Chinese.[973] Despite their activities in the area, the Honduran vessels do not report any swordfish catch in the Pacific, but only a small catch in the Indian Ocean (Latin America, appendix C2c). Korea requires flag-of-convenience vessels owned by their fishermen to report the catch.[974] The authors, however, know of no similar Taiwan requirement. Almost certainly swordfish is being taken by these vessels and not reported. Chilean inspections of the Honduran longliners transhipping tuna through Arica in 1996 reveal that over 5 percent of the catch is swordfish.[975]

Japan: Japanese companies targeting tuna have been extremely active off many countries. While many Japanese fishing companies have been involved in Chile, tuna and swordfish do not appear to have been the species of major concern.[976] Some Japanese companies active in Chile have deployed trawlers, but none have deployed longliners to target tuna and swordfish. (See "Joint ventures below.") The Japanese do, however, operate large tuna longline fleets in the southeastern Pacific and are the only distant-water country currently reporting swordfish catches. The swordfish taken by the Japanese in the southeastern Pacific (appendix E5 and figure 19) primarily results from the by-catch of the tuna longline fishery.[977] Catch patterns and grounds reported by the Japanese are discussed above. (See "Species" and "Fishing Grounds".) Tuna is the primary Japanese target species because it commands prices in the domestic market about twice that of swordfish.[978] Chilean artisanal fishermen report spotting Japanese longliners off Chile outside the 200-mile zone.[979] Some of these vessels purchase licenses from neighboring Peru. Port call data supplied by the Chilean Navy suggests relatively limited Japanese activity off Chile during 1996-97 (appendix D4), although much of the Japanese longline catch is transshipped at sea. SERNAP reports some transshippments through Arica in 1995 (photo 142).[980] (See "Transshipments.") The principal Japanese target species has varied, but in recent years has been primarily bigeye. The Japanese also, however, conduct directed swordfish sets if they encounter concentrations of other desirable species. Swordfish require sets at times/depths and in ocean conditions different than sets targeting tuna. The level of catches reported by the Japanese suggest that at least some of their effort is directed at swordfish. The Japanese report that their swordfish catches in the southeastern Pacific (FAO area 87) is notable, but usually less than 1,000 t (appendix E5 and figure 19). They have been reporting declining catches in recent years, less than 500 t in 1995, down substantially from the 690 t of swordfish in 1994 and the record 1,030 t reported in 1991.

Korea: Korean companies have operated trawlers in Chilean waters, but the authors know of no longliners conducting swordfish/tuna operations. The Koreans do

Photo 143.--Taiwan-owned vessels are not active off Chile, but flag-of-convenience vessels like this Panama-flag longliner in New Zealand are active. Dennis Weidner.

operate longliners in the eastern Pacific. They reported small swordfish catches in the early 1980s (appendix E5 and figure 19), but none since 1991. Chilean fishermen continue to report the presence of Korean longliners outside the 200-mile limit.[981] Korean fishery officials, however, report no or minimal activity off Chile in recent years.[982]

Panama: Chilean officials report that Panamanian vessels are transshipping tuna through Arica.[983] (See "Transshipments.") The vessels involved are presumably longliners operated as flag-of-convenience vessels. Little information is available on these vessels, but they may be operated primarily by Spanish and Taiwan owners.[984] Taiwan ownership is most likely given the fact that the crews are Chinese. Despite their presence in the area, the Panamanian vessels do not report any swordfish catch in the southeastern Pacific (appendix E5 and figure 19). Almost certainly, swordfish is being taken by these vessels and not reported. Chilean officials noted small quantities of swordfish in the holds of Panamanian-flag longliners transshipping tuna through Arica in 1995.[985] Taiwan and Taiwan-owned flag-of-convenience vessels, like Taiwan-flagged vessels, are more active in the western Pacific and south Atlantic (photo 143).[986]

Peru: Peru through 1996 had no dedicated swordfish fishery. A few small longliners have been deployed in 1997.[987] Peruvian fishermen report small swordfish catches as a result of small fisheries targeting sharks or tunas. The Peruvian effort is focused primarily in coastal waters. There is no known Peruvian swordfish catch off Chile, although the newly deployed small longliners are fishing along the Chilean border (Peru, appendices B8a1-2). Peruvian Government policies are of concern to Chilean fishermen. Peru permits foreign fishermen to operate out of domestic ports. This enables the Spanish and other foreign fishermen to conduct swordfish operations in the waters off Peru and Chile. The ability to transship through regional ports makes the operations more economically viable because the vessels can stay on the grounds longer and do not have to carry each load to a distant port. While the foreign fishermen theoretically operate outside of 200-miles, they are targeting the same stock harvested by Chilean fishermen. As the Chilean catch has declined since 1991, many Chilean fishermen are disturbed with the foreign fishing. They are convinced that by permitting foreign fishermen to use their ports, Peru has contributed to the catch declines since 1991.[988]

Spain: Four Spanish companies (Concar, Pescanova/Pesca Chile, Suribérica, and Viera) have operated longliners and trawlers out of Chilean ports (mostly Punta Arenas). The vessels have been deployed in both the Atlantic and Pacific. Both the longliners and trawlers are believed to have targeted primarily demersal species. Some of the longliners have been deployed for swordfish through Chilean-Spanish joint ventures.[989] Most of the Spanish swordfish effort in the southeastern Pacific, however,

Photo 144.--Spanish fishermen have been active in the southeastern Pacific, but the number of vessels has varied widely. Dennis Weidner.

appears to have been distant-water operations by small Spanish companies. One observer estimates that as many as 40 Spanish longliners operated off Chile and Peru during the early 1990s.[990] The Spanish withdrew from the southeastern Pacific in 1994-95, but a few vessels returned in 1996. Chilean fishermen in early 1997 reported spotting Spanish longliners off Chile outside the 200-mile zone.[991] The authors have been able to obtain little information on the Spanish fleet. The companies involved, with a few exceptions, are very reluctant to discuss their operations. There are, however, occasional references in the Spanish press, primarily complaints that Chile does not allow them to transship swordfish.[992] The Spanish Asociación Nacional de Armadores de Buques Palangreros (ANAPA) has repeatedly criticized Chilean restrictions on transhipping and asked the Spanish Government and EU authorities to intervene.[993] A small number of Spanish longliners appear to have returned in 1995 and are currently operating in the southeastern Pacific. The authors have noted less than 10 longliners during 1996-97, but it is unclear how many were actually operating at any given time (Peru, appendix A2 and Chile, appendix D4).[994] One of the fishermen involved reports that his vessel (the *Maicoa*) was the only Spanish vessel operating as a distant-water vessel in the Pacific during 1996.[995] But there appear to haver been a few others. As a result, of the Chilean restrictions, they use Ilo and other Peruvian ports to transship (photo 144).[996] The Spanish vessels are, however, allowed to call at the Chilean port of Arica and regularly obtain bait and other supplies there. (See "Ports.") Their bait is shipped from Spain. Arica is preferable to Ilo because there is much more regular freight service.[997] **Taiwan**: Chilean fishermen charge that Taiwan longliners are active off Chile, outside the 200-mile limit.[998] There is some reported activity by Taiwan-owned flag-of-convenience vessels (appendix D4). (See "Honduras" and "Panama" above.) SERNAP reports a small number of inspections when these vessels have called at Chilean ports and found some swordfish as part of the catch.[999] Taiwan researchers, however, report no swordfish taken in the southeastern Pacific and very limited effort. Taiwan longliners appear much more active in the western Pacific and south Atlantic (photo 145).[1000]

United States: There are currently no U.S. fishing vessels operating in Chilean waters. The authors know of only limited U.S. fishing operations in the south Pacific during recent years. United States swordfish longliners in the Pacific primarily operate north of the Hawaiian Islands, although a few also operate out of southern California.[1001] Operations in the south Pacific for swordfish are unusual. One press report indicate that some U.S. swordfish longlining was conducted off Chile in 1989.[1002] One U.S. fisherman reported swordfish and tuna catches outside Chilean waters in 1991-92. He operated out of Arica, but transhipped the swordfish catch through Peruvian ports because of Chilean restrictions on transshipping swordfish through Chilean ports.[1003] Other U.S. fishing vessels are operating in the south Pacific targeting albacore. U.S. fishermen troll for albacore primarily in the north Pacific, but there are also some south Pacific operations, as far south as 45°S. The south Pacific operations have been centered mostly in the western Pacific west of 130°W. Some fishing was conducted as far west as the Tasmanian Sea between Australia and New Zealand. Available data for 1993-94 show that fishing was attempted somewhat to the east (130°-110°W), but no catches were reported.[1004]

USSR: The Soviets reported no swordfish catches in the massive mid-water trawl

Photo 145.--Taiwan-flag vessels have not operated off Chile in recent years, but are active in the South Atlantic off Uruguay and Brazil. Dennis Weidner.

fisheries conducted in the southeastern Pacific (outside 200-miles off Chile and Peru) (appendix E5).[1005] Peruvian officials reported, however, that the Soviet operations permitted within the 200-mile zone did result in incidental swordfish catches (Peru, appendices b3c1-d1).[1006] It is unclear if this means that there were, in fact, incidental catches associated with Soviet mid-water trawling or whether Soviet operations within 200-miles employed substantially different methods--thus resulting in the swordfish by-catch.[1007] One expert on Soviet fishing believes the swordfish by-catch was probably associated with the trawl fishery off northern Peru where swordfish are known to have been abundant.[1008]

Uruguay: Some Chilean longliners are deployed in the Atlantic out of Montevideo. The vessels do not fish in Uruguayan waters and thus no Uruguayan fishing permits are required. The Uruguayan Government permits Chilean, Spanish, Taiwan, and other foreign fishermen operating on the highseas to use the port of Montevideo to transship and purchase supplies.[1009] The principal Chilean company involved is Pesquera Omega. IFOP reports Chilean swordfish exports to Uruguay (appendices J2f1-2 and figure 133). The product involved may have been the fish landed by these vessels.

2. Multilateral

Swordfish in the southeastern Pacific has received only limited attention from multilateral groups. Several groups involved with tuna in the western Pacific (Indian Ocean Fisheries Commission, Indo-Pacific Fisheries Commission, South Pacific Commission, South Pacific Forum Fisheries Agency, and others) have shown some interest in swordfish. Work in the southeastern Pacific has proven much more limited. In part this is due to the small number of coastal countries involved. Chile and Peru are the only coastal countries in the southeastern Pacific (FAO area 87) and only Chile has an active fishery. In addition there are only a small number of distant-water countries active (Japan, Spain, and Taiwan). The primary multilateral groups are:

Eastern Pacific Ocean Tuna Organization: This organization was created in 1995 as a result of a long series of negotiations sponsored by the Organización Latinoamericana de Desarrollo Pesquero (OLDEPESCA). The agency is not yet active and if and when it begins work will almost certainly focus on tuna. Swordfish would likely be a low priority, if addressed at all.

International Symposium: Researchers from various countries are expanding work on swordfish, in part because of the increasing fishing pressure and concern over stocks. Most researchers believe that given the highly migratory nature of the fish, a full understanding of the stock structure will require a cooperative international research effort. An international symposium on Pacific swordfish was held in Ensenada, Mexico during 1994. IFOP participated in the symposium, delivering a paper on the Chilean fishery and research program. IFOP also participated at a second symposium held in Hawaii during 1997 and delivered several papers.

Inter-American Tropical Tuna Commission: The IATTC was formed in the early 1950s to manage ETP tuna resources. Chile is not a member of IATTC because the organization has focused on tunas, especially yellowfin which occurs primarily in tropical waters to the north of the country. Chile has had little interest in IATTC because of the country's minor involvement in the tuna fishery. IATTC has two primary programs. One is the Tuna Billfish Program. While the primary focus has been on tunas, some work has also been done on swordfish and other billfish.[1010]

Chile was active in the negotiations of the international convention on straddling fish stocks and highly migratory species conducted during 1994 and 1995. A convention was finally adopted by a U.N. conference on August 4, 1995. Some Chilean industry representatives were critical of the treaty, believing erroneously that it requires coastal countries to grant access to foreign fishermen. Christian Jara, SONAPESCA's President, charged that if Chile signs the treaty, "... we would be obliged to negotiate TACs or other regulatory measures that would give away our fishing resources to distant countries." Other industry spokesmen, including representatives of the artisanal and commercial fishermen were also critical, although many also had incorrect information about the treaty.[1011] Chilean officials are more favorably disposed. Chilean Economy Minister, Alvaro Garcia Hurtado believes that Chile should sign the treaty.[1012] Chile did not, however, sign the treaty and as of December 1996 has not acceded.

B. Foreign aid

A few bilateral and multilateral donors have provided assistance which has, at least indirectly, assisted in the swordfish fishery. The most significant assistance, however, has been the virtually free access to the U.S. market for Chilean exporters.

Canada: The Canadian Center for International Investigation and Development (CIID) during the 1980s assisted artisanal fishermen improve their gear and fishing methods. CIID has also assisted the UCV with its work on satellite imaging.[1013] (See: "Research.")

Inter-American Development Bank: The IDB-financed fishing program helped to significantly expand the artisanal fleet during the early 1980s. (See "Fleet.") Many of these vessels were subsequently deployed in the swordfish fishery.[1014] The project channeled about $16 million into artisanal fisheries during 1983-85, especially along the central coast, In San Antonio alone the number of artisanal vessels increased from 70 to 170 boats. Many of these new boats were deployed seasonally in the toothfish and swordfish fisheries.[1015]

United States: The open trade policies of the United States have played a key role in the development of the Chilean swordfish fishery. (See "Markets: Exports.") While not a foreign aid program, access to the U.S. market played a decisive role in the development of the fishery and the United States continues to be the principal market. There has been some other U.S. assistance. U.S. researchers conducted the first assessment of large pelagic resources off Chile.[1016] NOAA remote sensing data has proven highly beneficial to the swordfish fishermen. (See "Gear and Fleet Operations: Remote sensing.") Cooperative research efforts with NMFS are assisting Chilean researchers, although this is more of a cooperative effort benefitting both countries than a foreign assistance program as such.

C. Joint ventures

Few details are available as to joint ventures with foreign companies involved in the Chilean swordfish fishery.[1017] The Chilean fishing industry is largely owned and operated by domestic investors. There have been some significant participation by foreign companies, however, ownership is largely Chilean. Some foreign citizens resident in Chile are partners or owners of Chilean companies involved in the swordfish fishery and there may be some other foreign ownership as well, although details are lacking. These operations appear to have played an important role in introducing modern processing and fishing methods to Chilean fishing companies and fishing operations targeting swordfish.

Japan: Several Japanese companies have participated in the Chilean fishing industry.[1018] Their involvement in longline operations, however, appears to have been limited. The New Nippon company was involved with groundfish longline operations.[1019] The only Japanese involvement with swordfish known to the authors is the possible participation in Pesquera Montemar.

Netherlands: There apparently was some Dutch involvement in Pesquera Santa Lucía.

Spain: The authors know of no Spanish joint venture engaged with in swordfish in Chile. Spanish influence is notable, however, in the gear and fishing strategies of the Chilean fishermen. Only a few of the Spanish companies, however, are involved with swordfish. One report suggests that a Spanish company (Pesquera Española Bacalao) is associated with Empresa del Estrecho, but details on the contractual relationship are not available. The authors have also received unconfirmed reports that another Spanish company (Pesquera Apóstol Santiago) is active in the Chilean swordfish fishery. The largest Spanish company (Pescanova) active in Chile through its local subsidiary (Pesca Chile) does not appear to be involved with swordfish. Pesca Chile is primarily involved in groundfish and salmon processing. The Spanish activity out of Ilo (Peru) is primarily due to Chilean regulations which prohibit foreign-flag vessels from transshipping Pacific swordfish through Chilean ports. Pescanova is involved in the Atlantic swordfish fishery out of Montevideo.[1020] Other Chilean companies involved with longline joint ventures include: Concar, Pesquera Iberchile, and Pesquera Suribérica. Like Pesca Chile these ventures appear to focus on bottom longlining for groundfish.[1021] There has been, however, a significant Spanish influence on the Chilean swordfish fishery as most of the Chilean fishermen through 1996 use Spanish-style longline methods. (See "Gear and Fleet Operations.")

United States: U.S. citizens resident in Chile are involved in various Chilean companies, including Pesquera Atún Mar, Pesquera Catalina, and Pesquera Omega. Each of these operations have played an important role in introducing modern fishing methods and fish handling and processing procedures for swordfish to Chile.

XVII. Enforcement

Chile's primary international enforcement problem is currently with neighboring Peru. The Peruvian fleet is active along the southern coast and involves a large number of seiners. There are occasional seizures.[1022] There is only limited Argentine activity along the southern coast. Some distant-water countries are active in the southeastern Pacific. The largest foreign effort was conducted by the Soviets on jack mackerel, but this fishery was discontinued after the dissolution of the Soviet Union and Russian companies found it to be uneconomical in a market economy.[1023] No actual seizures, however, occurred despite the massive Soviet effort. Japanese and Spanish longliners are currently active in the southeastern Pacific for tuna (Japan) and swordfish (Japan and Spain). The authors also know of no actual longline seizures. Given the capabilities of the chilean Navy, this suggests that perhaps with the exception of the 200-mile EEZ periphery that foreign longline fishing within Chilean waters is not extensive.

Available information on incidents involving foreign and Chilean fishermen and vessels include:

Argentina: Small Argentine fishing vessels make occasional incursions in Chilean waters (appendix D4). Two Chilean factory vessel were seized in 1980 by the Argentines. One vessel, the *Rosales*, was seized off the Falklands.[1024] The second vessel, *Miño*, was associated with a Spanish company.[1025] The vessel was held for 2 months and finally released after paying a $300,000 fine and had her catch confiscated.[1026]

Japan: Chilean authorities detained five Japanese fishing vessels, some presumably longliners, in Punta Arenas, Talcahuano, and Chacabuco during 1989. There was no fishing incident involved. Japan had embargoed Chilean grapes as a result of what was later found to be erronious reports from the United States. Naval Chief of Staff Patricio Urbina indicated that the vessels would not be allowed to sail until the Japanese fruit market was opened.[1027]

Peru: Chilean seizures of Peruvian fishing vessels, primarily small seiners, occasionally are reported.[1028] A very small number of Chilean vessels are seized by the Peruvians.[1029] (For a fuller discussion see the Peruvian chapter of this report.)

Soviet Union: The Soviets deployed a very substantial fleet in the southeastern Pacific off Chile during the 1980s.[1030] The authors know of no actual seizures, but the Chilean Navy did report Soviet fishing within its EEZ and fired on at least one Soviet trawler in 1990.[1031] The Chilean Government submitted an official protest to the Soviets.[1032]

United Kingdom: Falkland officials in December 1995 arrested 21 Chilean fishermen working aboard a Spanish trawler in the South Atlantic. the fishermen complained of having to spend Christmas in jail.[1033]

Other: Several incidents have been reported involving the sinking of Chilean fishing vessels, allegedly by merchant ships from Norway, Brazil, and other countries.[1034]

Photo 146.--Chile's enforcement program is administered by Alejandro Covarrubias who has helped plan the new satellite vessel monitoring system. Dennis Weidner.

Chilean officials in 1997 hope to finalize their satellite vessel monitoring system (VMS). The two agencies involved with fisheries enforcement are SERNAP and the Navy ("Marina"). SERNAP is primarily involved with onshore inspection (photo 146). The Marina provides platforms for at sea enforcement (photo 147). Chilean officials because of the difficulties and cost of enforcing the country's 200-mile zone have

Photo 147.--The Chilean Navy provides at-sea platforms for fisheries enforcement. Dennis Weidner.

been actively pursuing a satellite VMS. SERNAP has assessed various systems. Foreign vessels desiring to fishing in Chilean waters were required to carry VMS transponders in 1996. SERNAP and SSP have recommended that a similar system be introduced to domestic fishermen, both to facilitate enforcement of fishery regulations and has a safety measure. The Chilean Congress has approved a VMS program which will be jointly administered by SERNAP and the Navy. The President is expected to sign the measure. SERNAP and Navy officials are hopeful the law can be signed by late September 1997.[1035]

Photo 148.--SERNAP has no planes, but contracts small planes to conduct surveillance flights. The Region VIII Enforcement Director was tragically killed during a flight in 1996. D. Weidner.

XVIII. Future Trends

The Humboldt Current and associated east-west currents in the southeastern Pacific create a productive ecosystem supporting an important population of swordfish. This southeastern Pacific population appears to be separate, but not isolated from swordfish in the wider-Pacific, although such a conclusion is still preliminary. Chilean artisanal and commercial fishermen have developed an important fishery since the mid-1980s, the largest Latin American fishery for this species. The Chilean and distant-water foreign fishery appears to have exceeded the maximum sustainable yields of the stock, but the lack of information on the stock structure also makes this conclusion preliminary.

Chilean fishermen have substantially reduced effort since the fishery peaked in 1991. The coastal artisanal driftnet fishery in particular reached especially low levels in 1996. In part this was a response to more profitable alternative fisheries, so the reduced 1996 effort may not have been a permanent withdrawal from the fishery. The commercial effort is more complicated. Several longliners have been withdrawn from the fishery, but the vessels remaining were more intensively deployed in 1996. Foreign distant-water fishing patterns are mixed. The large Japanese fishery has reduced effort through 1995, but the more limited Spanish fleet, after withdrawing in 1994-95 from the Pacific are returning in 1997.

The character of the Chilean fishery appears to be changing. The artisanal fishermen who had been reporting declining profitability as catches plummeted in coastal waters, largely switched to other fisheries during 1996. The 1997 artisanal catch appears to have improved somewhat, but continues at much reduced levels. It is possible that the commercial fishermen who are able to reach still productive offshore grounds may dominate the fishery in the future. The Chileans have the potential to significantly increase fishing, but the current state of the resource may prevent them from doing so. Some increased effort is likely as the commercial fishermen by shifting to fresh product appear to have demonstrated the ability to conduct profitable operations. The impact of the minimum size regulations approved in 1997, however, is yet to be assessed.

One potentially important factor in 1997-98 is the powerful developing El Niño. Most climatologists believe that it may develop by 1998 as one of the most powerful El Niños ever. The influence of such a powerful event could linger for several years. The impact on swordfish catches is yet to be determined, but many regional and foreign observers have demonstrated that swordfish distribution is affected by such events as well as longer-term climatic trends.

The Chileans strengthened their management regime in 1997 by implementing a size limit. Other countries fishing in the southeastern Pacific, however, both distant-water (Japan and Spain) and coastal (Ecuador and Peru), have no such limits. Most of those countries are expanding their fisheries, although the overall effort is still only about half of that reported at the peak of the fishery in 1991.

Chilean companies appear to be shifting their processing mix. Chile was the only Latin American country that processed substantial quantities of value-added loins, steaks, and other processed products. Companies continue to process large quantities, but are now shipping a sharply higher proportion of H&G trunks without further processing. This appears to be a response to demand trends in the United States where most of the Chilean catch is marketed. Some U.S. importers believe that importing whole trunks improves the quality of the product which appears to justify the higher processing costs in the United States.

The SSP has made swordfish a priority and IFOP is coordinating a research effort designed to understand the stock structure and assess the population off Chile. It is the most important Latin American research effort currently underway on swordfish. Chile is cooperating with other Pacific countries also attempting to assess the swordfish stock structure.

SOURCES

Achurra L., Manuel. "El intenso esfuerzo para coquistar mercados externos," *Chile Pesquero*, April-May, 1994, pp. 17-24.

Adduard, Marcelo. Export Manager (Latin America), Comercial Cisandina, personal communications, January 22, 1997 and February 27, 1997.

AFP. Various broadcasts.

Aguayo, Anelio, Rene Maturana C., and Daniel Torres N. "Antarctic fur seal, *Arctocephalus gazella* (Peters), in the Chilean Antarctic sector," source document unavailable.

Aguayo, A., R. Bernal, C. Olavarría B., V. Vallejos M., and R. Hucke G. "Observaciones de cetáceos realizadas entr Valparaíso e Isla de Pasca, durante el invierno de 1993, 1994 y 1995," in 7ª Reunión de Trabajo de Especialisyas en Mamíferos Acuáticos de América del Sur/1° Congreso de la Sociedad Latinoamericana de Especialistas en Mamíferos Acuáticos, October 22-25, 1996, Viña del Mar, Chile.

Alfonso, and Elizabeth Palta. "El mercado de productos del mar frescos en Chile," *Boletin Informativo SIM*, No. 29, November, 1994, pp. 10-12.

Anusch, Cristobal. Controler, Pesquera Omega. Personal communications, November 21, 1995.

Arancibia, Jaime. Systems Specialist, Centro de Estudios Espaciales, Universidad de Chile. Personal communications, January 29, 1997.

Aranis R., Antonio. "Presente y futuro de la industria pesquera de San Antonio," *Boletin Informativo SIM*, N°32, September, 1995, pp. 10-14.

_____. "Vision de sector pesquero," *Boletín Informativo SIM*, No. 35, June 1996, pp. 19-22.

Arenas, Pablo. Instituto Nacional de Pesca (Mexico), personal communivations, September 26, 1997.

Arias, Juan Luis. "El mercado americano del pez espada (albacora): Su evolución e implicaciones para Chile," *Boletín Informativo SIM*, N°19, May 1992, pp. 3-5.

Arocha, Freddy. Universidad de Oriente (Venezuela), personal communivations, August 25, 1997.

Arraya, Gabriel. Captain of the *Santa Rosa*. Personal communications, April 8, 1996.

Asakawa, Tomohiro. U.S. Foreign Commercial Service, U.S. Embassy, Tokyo. Personal communications, January 29, 1997.

ASMAR News, various issues.

Azocar, Jaime. Manager/Owner, Pesquera Santo Domingo. Personal communications, November 15, 1996 and January 23, 1997.

Bacigalupo, Héctor. SONAPESCA. Personal communications, November 12, 1996.

Bahamondes, Roberto. IFOP, Comments at the United States-Chile Fishery Cooperation Talks, Santiago, Chile, April 1-2, 1996.

Bailey, Kevin. "Description and surface distribution of juvenile Peruvian jack mackerel *Trachurus murphyi* Nichols from the Subtropical Convergence Zone of the central South Pacific, *Fisheries Bulletin*, Vol. 87, No. 2, pp. 273-278.

Barbieri, Maria Angela Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez R., Antonio Gonzalez Casanga, victor Catasti Barraza, and Marcelo Garcia Alvarado. "Monitoreo de la pesquería recurso pez espada (I-X Regiones), 1994," Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), 81p.

Barbieri, Maria Angela, Jefe, Departamento de Tecnologia Pesquera, IFOP. Personal communications, April 11-12 and December 18-19, 1996 and January 3 and 29 and March 4, 1997.

Barbieri, M. A., M. Donoso, A. Gonzalez, V. Correa, B. Leiva, and A. Montiel. "Development and state of art of the swordfish fishery in Chile," paper delivered at the International Symposium on Pacific Swordfish, Ensenada, B.C., Mexico, December 11-14, 1994.

Barbieri, M.A., F. Naranjo, E. Yáñez, M. Farías, G. Danneri, and P. Rojas. "La pesquería artesanal de atún aleta larga en la zona de Valparaíso y el satélite NOAA," *Invest. Mar.*, Valparaíso, 1987, Vol. XV, pp. 14-61.

Barbieri, M. Angela, Eleuterio Yáñez R., Luis Ariz A., and Antonio González C. "La pesquería del pez espada: Tendencias y perspectivas," in *Perspectivas de la Actividad Pesquera en Chile* (Escuela de Ciencias del Mar, UCV: Valparaío, Chile, 1990), pp. 196-214.

Barrientos, Jaime. Interviewed by Antonio Aranis R., "Presente y futuro de la industria pesquera de San Antonio," *Boletin Informativo SIM*, September, 1995, pp. 10-14.

Bartoo, Norman W. and Atilio L. Coan, Jr. "An assessment of the Pacific swordfish resource," in R.H. Strod (ed.) *Planning the Future of Billfishes: Research and Management in the 1990s and Beyond*, Part 1 (National Coalition for Marine Conservation: Savannah, Georgia, 1989), pp. 137-151. The Coalition's publication was the *Proceedings of the Second International Billfish Symposium*, held at Kaila-Kona, Hawaii, August 1-5, 1988.

Beck, John. Manager, Pesquera Isla del Rey. Personal communications, November 20, 1996.

Beckett, J.S. "Biology of swordfish, *Xiphias gladius*, L. in the Northest Atlantic Ocean," in R.S. Shomura and F. Williams, ed. *Proceedings of the International Billfish Symposium*, Hawaii, August 9-12, 1972, part 2, pp. 103- 106.

Bedford D., and F. Hagerman. "The billfish fishery resources of the California Current," *CALCOFI Report*, 1983, Vol. XXIV, pp. 70-78.

Bermejo, Alejandro. "Boom harinero en area de Talcahuano (Chile)," *Pesca*, May-June, 1987, pp. 6-12.

Bernal, Patricio. Subsecretario de Pesca. Comments at the United States-Chile Fishery Cooperation Talks, La Jolla California, March 20, 1995.

_____. Comments at FAO Committee on Fisheries session, Rome Italy, March 14-15, 1995.

Blinsinger, Kirt. Personal communications, August 28, 1995.

Böhm S, Maria Gabriela. "Pesquera pelágicas: Zona central sur. Estado de situación y perspectivas del recurso," *Diagnóstico de las Principales Pesquerías Nacionales*, 1993, SGI/IFOP 94/6 (IFOP/CORFO: Santiago, 1994), pp. 35-47.

Boletin Informativo SATAL, various issues.

Bornscheuer, Guillermo. Director de Estadísticas, SERNAP, personal communications, October 1 and 4, 1997.

Brito Montero, José Luis. Museo Municipal de Ciencias Naturales y Arqueologia de San Antonio, personal communications, March 16, 1997.

Brito M., José L. "Nuevos registros de cetaceos para las aguas de Chile central," in 7ª Reunión de Trabajo de Especialisyas en Mamíferos Acuáticos de América del Sur/1° Congreso de la Sociedad Latinoamericana de Especialistas en Mamíferos Acuáticos, October 22-25, 1996, Viña del Mar, Chile.

Brito, José. "Las tortugas marinas en Chile: Su situación actual," XIV Jornadas de Ciencias del Mar/1 Jornada Chileana de la Salmonicultura, May 23-25, 1994, Puerto Montt, Chile.

Brito M., José L., and Julio C. Reyes. " Registro de cetaceos en aguas de Chile central," 4ª Reunion de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur, November 12-15, 1990, Valdivia, Chile

Burgos, Adel. Administrative Assistant, APEVAL. Personal communications, January 27, 1997.

Canihuante, Gabriel. "Fisheries-Chile: Problems with new treaty," Inter Press Service English News Wire, January 11, 1996.

Capurro, Carlos. Economic Section, U.S. Embassy, personal communications, July 29, 1987 and September 16, 1993.

Caro, Artemio. Pesquera Santa Lucia. Personal communications, November 6, 1996.

Carocci, Fabio and Jacek Majkowski. *Pacific Tunas and Billfishes; Atlas of Commercial Catches* (FAO: Rome, 1996).

Carvajal Leon, Herman. Region IV Director, SERNAP. Personal communications, April 9, 1996.

Carrasco, Rolando. General Manager, Pesquera del Estrecho. Personal communications, November 6, 1996.

Childers, John, and Forrest R. Miller. "Summary of the 1994 U.S. north and south Pacific albacore troll fisheries," *Southwest Fisheries Science Center Administrative Report*, LJ-95-15, July 1995, 57p.

Chile Economic Report, various issues.

Chile Pesquero, various issues.

Chilean Embassy (Washington). *Chile*, September 4, 1996.

Chilean Government. Decreto N°66, January 27, 1995.

_____. Decreto N°293/95.

_____. Ley N°430, September 28, 1991

_____. Ley N°600, article 19.

_____. Ley N°18.565, October 26, 1986.

_____. Ley N°18.892, Ley General de Pesca y Acuicultura of 1989.

_____. Resolució N°135, February 14, 1992.

_____. Resolución N°1225, December 27, 1994.

_____. Decreto N°2167/96, December 26, 1996

_____. Resolución N°406, March 14/April 2, 1997.

_____. Resolución N°39, January 29, 1997.

_____. Supreme Resolution 179, April 14, 1953.

Chilean Navy, surveillance summaries, unpublished data, July 18, 1997.

Chong Lay-Son, Javier. Universidad Católica de Sma. Concepción. Personal communications, December 4 and 17, 1996 and April 23, 1997.

Chong J., J.R. Galleguillos, R. Gonzalez, and M. Donoso. "Projecto: Estudio del proceso reproductivo, fecundidad y marcadores genéticos en el pez espada (*Xiphias gladius*, Linneo), Universidad de Concepcion, 1996, summary provided by Chong, personal communications, April 23, 1997.

Clavería, Gaston. SERNAP Provincial Director, San Antonio. Personal communications, April 12, 1996.

Contreras, Humberto. EMPAC. Personal communications, December 18, 1995.

Correa, Vilma. Subsecretarí'a de Pesca, comments at the United States-Chilean Cooperative Fishery Talks, July 24, 1997.

_____. Personal communications, October 10 and 17, 1997.

Cortés D., Ricardo. Editor, *Catálogo Tecnico de*

Buques Pesqueros y Remolcadores de Alta Mar (EDITC: Santiago, 1994), 352 p.

Covarrubias, Alejandro. Director de Fiscalización, SERNAP. Personal communications, October 13, 1993; August 17 and 18 and October 17, 1995; January 28 and April 12, 1996; and January 27-28, February 14 and 25, July 27, and September 17, 1997.

_____. Departamento de Fiscalización, "Infrastructura de apoyo a la pesca deportiva marina en Chile," (SERNAP: Valparaíso, 1996), 25p.

_____. Comments at United States-Chile Fishery Cooperation Talks, La Jolla California, March 20, 1995.

_____. Comments at the United States-Chile Fishery Cooperation Talks, Santiago, Chile, April 1-2, 1996.

Crammer, Jean. "Large pelagic logbook newsletter-1994," *NOAA Technical Memorandum*, NMFS-SEFSC-378, November 1995

_____. "Large pelagic logbook newsletter-1995," NMFS-SEFSC-394, November 1996.

De Sylva, D.P. "Red-water blooms off northern Chile, April-May 1956, with reference to the ecology of the swordfish and striped marlin," *Pacific Science*, 1962, Vol. XVI, No. 3, pp. 271-279.

Defeo, Rick. Presentation at the United States-Chilean Cooperative Fishery Talks, July 24, 1997.

Diario el Sol, various issues.

Dollar, Robert A. "Annual report of the 1993 Western Pacific longline fishery," *Southwest Fisheries Center Administrative Report* H-94-06, August, 1994, 38 p.

Donoso, Miguel. IFOP. Personal communications, April 11 and December 20, 1996; and September 10, 1997.

Donoso, José Miguel, and Javier Chong Lay-Son. "Determinación de edad y estimación de crecimiento en albacora (*Xiphias gladius*, L). Etapa 1. Determinar la factibilidad de utilizar el metodo de lectura de marcas, bandas o annuli que se forman en estructuras duras, para determinar edad," *IFOP* (no series title) (IFOP: Valparaíso, 1992), 33p.

Donoso, M., and J. Chong. "Investigación clave edad-talla de desembarque de pez espada (*Xiphias gladius* L) durante la temporada de pesca 1995-1996," (IFOP: Valparaíso, 1996).

Donoso P., Miguel, and Javier Chong L-S. "Elaboración clave talla-edad de la albacora (*Xiphias gladius* L.) durante la temporada de pesca, 1994-1995," *IFOP*, no series title (IFOP: Valparaíso, November, 1995), 20p.

Donoso P., Miguel, and Carlos Montenegro. "Inves. monitoreo pesqueria de albacora temporada 1991," (IFOP N° inven: 920020), October 1992, 37p.

Donoso, Miguel and Rodolfo Serra. *La pesquería de pez espoada en Chile*, (IFOP: Valparaíso, 1997), 16p.

Dutton, Peter. Specialist on the Mollecular Ecology of Turtles, Comments at the United States-Mexico Fishery Cooperation Talks, Huatulco, Mexico, September 25, 1997.

DYN (Buenos Aires). Various broadcasts.

Echandía Zegarra, José. General Manager, TRAMARSA, personal communications, June 21, 1996.

Eckert, K.L. "The biolgy and population status of marine turtles in the North Pacific Ocean, " *NOAA Technical Memorandum*, 1993, NMFS-SWFSC-186, 156p.

Eckert, Scott. Hubbs-Sea World Research Institute, personal communications, September 26, 1966.

EFE (Madrid). Various broadcasts.

Empresa Portuario de Chile. "Coquimbo Ciudad Puerto," 1996.

Erbacher, Jerome. NMFS, personal communications, September 10, 1997.

Espinoza, F.R., S. Neshyba, and Z. Mexicano. "Surface water motion off Chile has revealed in satellite images of surface chlorophyll and temperature," *Proceedings of the International Conference on Marine Resources in the Pacific*, Universidad Católica de Valparaíso, 1983, pp. 41-57.

Farrington, Jr., S. Kip. *Fishing the Pacific: Offshore and On* (New York: Coward-McCann, 1953).

Fernández, Francisco and Julio A. Vásquez. "Al jibia gigante *Dosidicus gigas* (Orbigny, 1835) en Chile: Análisis de una pesquería efímera," *Estud. Oceanol.*, Vol. 14, 1995, pp. 17-21.

Fishing News International, various issues.

Folsom, William B. "Fisheries of Chile, 1971," *Foreign Fisheries Leaflet*, FFL73-21 (NMFS: Washington, D.C., 1973, 17p.

_____. "Western Europe," *World Swordfish Fishery*, Vol. 6, (NMFS: Silver Spring, MD, 1997).

Folsom, William B., Dale M. Crory, and Karyl Brewster-Geisz. "North America," *World Swordfish Fisheries*, Vol.V (NMFS: Silver Spring, 1997).

Fonseca, T.R. and M. Farias. "Estudio del preoceso de surgencia en la costa chileana utilizando percepción remota," *Investigación Pesquera*, Vol. 34, 1982, pp. 22-46.

Food and Agriculture Organization of the United Nations (FAO). *Yearbook of Fishery Statistics*, various years.

Frazier, Jack. CINVESTAV, personal

communications, February 23, 1997.

Frazier, Jack G. and José Luis Brito Montero. "Incidental capture of marine turtles by the swordfish fishery at San Antonio, Chile," *Marine Turtle Newsletter*, April, 1990, pp. 8-13.

Frazier, J.G. and S. Salas. "Tortugas marinas en Chile," *Bol. Mus. Nac. Hist. Nat. Chile*, 1982, Vol. 39, pp. 63-73.

Gaete Merino, Viviana. Departamento SIEP/SERNAP, personal communications, October 1, 1997.

González, A, M.A. Barbieri, and E. Yáñez. "Distribución espacio temporal de la pesquería artesanal de pez espada (*Xiphias gladius*) y variaciones ambientales en la zona de Valparaíso," *XII Jornadas de Ciencias del Mar*, May 27-29, 1992.

Grijalva-Chon, José M., Jorge de la Rosa-Vélez, and Oscar Sosa-Nishizaki. "Allozyme variability in two samples of swordfish, *Xiphias gladius L.*, in the North Pacific Ocean," *Fishery Bulletin*, Vol. 94 No. 3, 1996, pp. 589-594.

Guerrero, Osvaldo. Jefe de Flota, Pesquera del Estrecho. Personal communications, December 12, 1996.

Hanan, Doyle, A., David B. Holts, and Atilio Coan. "The California drift gillnet fishery for sharks and swordfish, 1981-82 through 1990-91," *Fish Bulletin* (California Department of Fish and Game), No. 175, 1993, 95p.

Hawaii Department of Business, Economic Development & Tourism, Ocean Resources Branch, "Shutome: Broadbill swordfish," WWW posting, January 31, 1997.

Hernández, M.P. *Informaciones Estadísticas Sobre Pesca*," Dirección de Pesca y Caza, Valparaíso, 56p.

Hinton, Michael G. and Richard B. Deriso. "Structure and assessment of stocks of swordfish in the eastern Pacific Ocean," *Sustaining Tuna Fisheries--Issues and Answers*, Proceedings of the 47th Tuna Conference, Lake Arrowhead, California, May 20-23, 1996.

Humphreys, Robert. "Review of larvae and juvenile distributions with inference towards spawning habitat," paper delivered at the Second International Swordfish Symposium, March 5, 1997, Turtle Bay, Oahu, Hawaii.

Industrias Pesqueras, various issues.

INFOFISH Trade News, various issues.

INFOPESCA Noticias Comerciales, various issues.

International Commission for the Conservation of Atlantic Tunas (ICCAT). "Recommendation by ICCAT regarding the implementation of an alternative option for the conservation of undersized Atlantic swordfish and the reduction of fishing mortality," Annex 4-10 in *ICCAT Report*, Part II (1995), Vol. 1 (Madrid: ICCAT, 1996), p. 88.

Instituto de Fomento Pesquero (IFOP). "Estado de situación y perspectivas del recurso," *Pesquerias Nacionales Demersales* (PECES), Zona Centro Sur, 1993, (IFOP: Valparaíso, April, 1994), 65p and appendices.

_____. *Memoria, 1994* (IFOP: Valparaíso, 1995).

_____. "Recurso albacora," *Estudio Biologico Pesquero*, doc. no. 900016, presumably 1990, 12 p.

_____. División Evaluación de Pesquerías. "Descripción de la pesqueria de pez espada en la temporada 1995," *Documento Preparado para la Reunion Anual Entre SUBPESCA/SERNAPESCA/IFOP y NMFS, 1996.*

Japan Marine Fisheries Resource Research Center (JAMARC). "Report on 1979 tuna longline fishing investigation in higher latitudes of the eastern south Pacific," *JAMARC*, No. 23, 147p.

Johnson, Donald R., Thomas Fonseca, and Helmuth Sievers. "Upwelling in the Humboldt coastal current near Valparaíso, Chile," *Journal of Marine Research*, February, 1980, pp. 1-16.

Joseph, James, William H. Bayliff, and Michael Hinton. "A review of information on the biology, fisheries marketing and utilization, fishing regulations, and stock assessment of swordfish, *Xiphias gladius*, in the Pacific ocean," *IATTC Internal Report*, N°24 (IATTC: La Jolla, 1994), 81p.

Justin, Michael. Fisheries Administrator, NMFS. Personal communications, October 19, 1995.

Kaczynski, Wlodzimierz. Research Associate Professor, Institute for Marine Studies, College of Ocean and Fishery Sciences, University of Washington, personal communications, July 9, 1997.

Kameya K., Albertina. Director, Estudios Económicos y Evaluación de Recursos Potenciales, Instituto del Mar (Peru), personal communications, August 14, 1997.

Koplin, Stephen. NMFS. Personal communications, December 27, 1996.

Kousky, Vernon. Climate Analysis Center, National Weather Service, NOAA. Personal communications, December 17, 1996.

Kravanja, Milan. NMFS. Personal communications, December 15, 1996.

Lampe, Harlan C. "Fisheries management in Chile: Aspects of the law and examples of its application," *Fisheries Management: Global Trends* (University of Washington: Seattle, June 14-16, 1994).

Laurs, Mike. NMFS Honolulu Laboratory, personal communications, July 3, 1997.

Leetma, Ants. Presentation on El Niño at the NOAA Climate Change Board, August 20, 1997.

Lizama F., Gerson, and and Fernando Naranjo G. "Utilización del palangre en la pesca del pez espada," *Chile Pesquero*, July-August, 1989, pp. 43, 45.

Lynn, Ronald. NMFS Southwest Fisheries Science Center, material prepared for the United States-Mexican Fishery Cooperation Talks, September 3-5, 1997.

Macol, Antonio. Manager, Pesquera Lacks. Personal communication, November 20, 1996.

Majkowski, Jacek. Department of Fisheries, FAO, personal communications, April 7, 1997.

Manning, John A. "Summary of investigations on the pelagic fish survey of Chilean waters with special reference to the swordfish, marlins, and tunas," 57-4, Marine Laboratory, University of Miami.

Mansilla, Adela. "Utilización de dessechos de albacora en productos para consumo humano," (IFPO N° inven: 890048), December 1989.

Marco. Promotional literature, 1994.

Marina (Chilean Navy). Unpublished port call data data, July 18, 1997.

Marquez, Rene. Mexican National Turtle Coordinator, Instituto Nacional de Pesca, Comments at the United States-Mexico Fishery Cooperation Talks, Huatulco, Mexico, September 25, 1997.

Marron, E. *Albacora*, (Random House: New York, 1957), 214p.

Martínez, Carlos. "Principales tendencias tecnológicas de la embarcación pesquera artesanal," in M.A. Barbieri, ed. *Perspectivas de la Actividad Pesquera en Chile* (Escuela Ciencias del Mar, UCV: Valparaíso, 1989).

Ministerio de Relaciones Exteriores. Statement, September 12, 1985.

_____. "Prospección de atunes y peces espadas en el Oceano Pacífico oriental al este de los 110°W: Segundo semestre de 1971," (IFOP N° inven: 740002), December, 1974.

Mora, Olga. Instituto Nacional de Pesca (Uruguay), Personal communications, April 15, 1996.

Muga, Leonard. Sales Manager, New Bay Products. Personal communications, November 15, 1996.

Munita O., Clara. "De los moais al desarrollo pesquero: ¿Un abismo insuperable," *Chile Pesquero*, November- December, 1987, pp. 27-31.

Muñoz Concha. Heriberto. Processing plant owner. Personal communications, November 20, 1996.

Muñoz H., Gonzalo. "Pesca de atunes frente a las costas de Chile y sus exportaciones," *Boletín Informativo SIM*, N°38, March 1997, pp. 13-15.

Munita Ortiz, Clara. Interview with Juan Rusque Alcaino, *Aquanoticias Internacional*, December 1992, p. 53.

Nakamura, Izumi. "Billfishes of the World," *FAO Species Catalog/FAO Fisheries Synopsis* (FAO:Rome, 1985).

Nakano, Hideki. Distant Water Fishery Research Laboratory, presentation at the First International Symposium on Pacific Swordfish, Ensenada, Mexico, December 11-14, 1994.

Nakano, Hiseki and William H. Bayliff, "A review of the Japanese longline fishery for tunas and billfish in the eastern Pacific Ocean, 1981-1987," *Inter-American Tropical Tuna Commission Bulletin*, Vol. 20, N°5 (IATTC: La Jolla, California, 1992), pp. 187-355.

National Fisheries Research and Development Agency (NFRDA) (Korea), "Fishery statistics and fishing grounds for the Korean tuna longline fishery, 1988-1992" *Technical Report of the NFRDA*, (NFRDA: Seoul, December 1993), 465p.

National Oceanogaphic and Atmospheric Administration (NOAA). El Niño Southern Oscilation NSO web site at: http://www.ogp.noaa.gov/enso/

Neff, Eduardo. As cited in "Chile's sword landings soar," *Seafood Leader*, Summer 1988, pp. 14, 16.

Nishimura W. and S. Nakahigashi. "Incidental capture of sea turtles by Japanese research and training vessels; results of a questionnaire," *Marine Turtle Newsletter,* 1990, No. 51, pp. 1-4.

Nisikawa, Honma, Yueyanagi, and Kikawa. *Average Distribution of Larval Oceanic Species of Scombroid Fishes, 1956-81* (Far Seas Fisheries Research Laboratory: Shimizu, Japan, 1985), Series S No. 12.

Olesen, Charles. "Informe al gobierno de Chile sobre la pesca con embarcaciones menores," *Informe FAO* N°907 (FAO: Rome, 1958), 48p.

Oliver, C. "Catálogo de los peces marinos del litoral de Concepción y Arauco," *Bol. Soc. Biol. Concepción*, Vol. XVII, 1943, pp. 75-126.

Ortego O., M. Isabela. "Reseña general del sector pesquero," *Boletín Informativo SIM*, No. 35, June 1996, pp. 1-9.

_____. Investigador, Departamento Economia Pesquera, Instituto de Fomento Pesquero, unpublished data, August 23 and October 9, 1997.

Pastor, Eduardo. SIPESCA (Peru), personal communications, June 3, 1997

Parrish, Richard. "Environmental variations and the validity of stock assessment of highly migratory species," paper delivered at the Second International Swordfish Symposium, March 4, 1997, Turtle Bay, Oahu, Hawaii.

_____. "Trip report for Richard Parrish's (PFEL) visit to Chile to attend an internatinal

meeting sponsored by the Insituto de Fomento Pesquer (IFOP) and held in Valparaíso, Chile on May 5-7, 1997," May 28, 1997.

Pereira, Enrique. Pesquerias Belnova. Personal communications, April 15, 1996.

Pesquera Catalina. "Desarrollo de una pesquería artesanal de meiana altura en la zona central," Informe Final, 1982, Volumes 1 and II.

Pesquera Marazul official. Personal communications, November 19 and 20, 1996.

Pinto G., Cristián. "La eficiencia economica de la pesqueria de jurel de la VIII Region: Resultados iniciales," *Boletín Informativo SIM*, No. 20, August, 1982, pp. 23-28.

Plotkin, Pamela T., Richard A. Byles, and David W. Owens, "Migratory and reproductive behavior of *Lepidochelys olivacea* in the eastern Pacific Ocean," in Barbara A. Schroeder and Blair E. Witherington, compilers, "Proceedings of the Thirteenth Annual Symposium on sea turtle biology and conservation," *NOAA Technical Memorandum*, NMFS-SEFSC-341 (NMFS-SEFSC: Miami, January 1994), p. 138

Podesta Guillermo. "Aspects of swordfish oceanography in the Atlantic," Second International Pacific Symposium, Turtle Bay, Hawaii, March 4, 1997.

Polanco Z., Rodrigo. Subsecretaría de Pesca, personal communications, September 22, 1997.

Pomar, Luis. *Historia de la Industria Pesquera en Chile* (Santiago, 1958).

Ponce, Ines. Treasurer, Pesquera Omega, personal communications, January 22, 1997.

Ponce Martínez, Francisco. Subsecretaría de Pesca, Personal communications, November 12 and December 17, 1996 and January 8 and 16, 1997.

Ponce Martínez, Francisco, and René Bustos. "La pesquería de pez espada *Xiphias gladius* Linnaeus, 1758 en Chile," *Revista Pacifífico Sur*, No. 19, 1991, pp. 25-34.

Quezada Rodríguez, Raúl. Technical Consultant/Founding Member, Asociación Gremial de Pescadores de Valparaíso, personal communications, January 22, 1997.

Quintana P., Marisol and Sergio Pino A. "IFOP ofrece a los exportadores un sistema de información pesquera en apoyo de su gestión exportadora," *Boletín Informativo SIM*, N°38, March 1997, pp. 16-19.

Radio Chileana Network (Santiagio). Various broadcasts.

Radio Cooperativa Network (Santiago). various broadcasts.

Reeb, Carol, Loretta Arangeli, and Barbara Block. "Using mitochondrial DNA swquence and microsatellite loci to examine population structure in Pacific swordfish," *Sustaining Tuna Fisheries--Issues and Answers* Proceedings of the 47th Tuna Conference, Lake Arrowhead, California, May 20-23, 1996.

Reiger, George. *Profiles in Saltwater Angling* (Englewood Cliffs: Prentice Hall, 1973).

(The) Review of the River Plate, various issues.

Reyes F., Eduardo. "Pesquería y mercado del pez espada," *Chile Pesquero*, July-August 1988, pp. 29-33.

Rohr, Benny A. NMFS Pascagolua Laboratory, personal communications, September 10, 1997.

Rusque, Juan. Director, SERNAP. Comments at the United States-Chile Fishery Cooperation Talks, Santiago, Chile, April 2, 1996.

Ruz, José I. Andesur. Personal communications, December 11, 1995.

Sakagawa, G.T. "Trends in fisheries of swordfish in the Pacific Ocean, in R.H. Strod (ed.) *Proceedings of the Second International Billfish Symposium*, Kaila-Kona, Hawaii, August 1-5, 1988, Part 1 (National Coalition for Marine Conservation: Savannah,Georgia, 1989).

Salas, Ramon. Chilean vessel captain working with SIPESCA (Peruvian company), personal communications, August 26 and September 1, 1997.

Sandino Corbet, Alejandro. Administrator, Astilleros y Maestranzas de la Armada (ASMAR). Personal communications, December 5, 1995.

Santiago Donestic Service. Various broadcasts.

Sateler, J. As cited in Serra, "Important life history aspects of the Chilean jack mackerel, *Trachurus symmetricus murphyi*," *Investigaciones Pesqueras*, Vol. 36, 1991, p. 81.

Schaefer, Richard. "Trip Report," Chilean trip, November 17-28, 1996, December 24, 1996.

_____. Chief, Staff Office of Inter-Governmental and Recreational Fisheries, NMFS. Personal commuications, December 20, 1996.

Schaub, Erich. "Una variable clave es la comercialización," *Chile Pesquero*, N°78, 1993, pp. 55, 59-60.

Schmidt, Jorge. Manager, Importadora y Exportadora Nanaimo. Personal communications, December 18, 1995.

Schmidt, Hans Louis. General Manager, Pesquera Omega. Personal communications, April 8, 1996.

Schroeder, Barbara. National Turtle Coordinator, NMFS, personal communications, September 4, 1997.

Seafood Business, various issues.

Seafood International, various issues.

Seafood Leader, various issues.

(La) Segunda, various issues.

Seki, Michael. NMFS Honolulu Laboratory, personal communications, August 25, 1997.

Serra, Rodolfo. "Important life history aspects of the Chilean jack mackerel, *Trachurus symmetricus murphyi*," *Investigaciones Pesqueras*, Vol. 36, 1991, pp. 67-83.

_____. IFOP, Personal communications, July 25, 1997.

_____. IFOP. Comments at United States-Chile Fishery Cooperation Talks, La Jolla Califonia, March 20, 1995.

_____. Presentation at the United States-Chilean Cooperative Fishery Talks, July 25, 1997

Servicio Agrícola y Ganadero (SAG), *Cartilla para Pescadores Deportivos*, 1977, 36p.

Servicio Naciinal de Pesca (SERNAP). *Anuario Estadístico de Pesca*, various years (SERNAP: Valparaíso, various years).

Servicio Nacional de Turismo (SERNATUR), *Guia de Pesca Deportiva en Chile*, 1984, 47p.

Shapiro, Sidney. *The Fisheries of Chile* (Bureau of Commercial Fisheries: Washington, D.C., 1965).

Sievers, Hellmuth A. and Nelson Silva S. "Masas de agua y circulación geostráfica frente la costa de Chile entre latitudas 18°S y 33°S," *Ciencia y Tecnolgía del Mar*, N°6, 1982, pp. 61-99.

Silva Martinez, Alexis. Pesquera del Estrecho. Personal communications, April 8, 1996 and December 12, 1996.

Silva S., Nelson. "Masas de agua y circulación en la region norte de Chile," *Ciencia y Tecnolgía del Mar*, N°7, 1983, pp. 47-84.

Skillman, R.A. "Status of Pacific billfish stocks," in R.H. Strod (ed.) *Proceedings of the Second International Billfish Symposium*, Kaila-Kona, Hawaii, August 1-5, 1988, Part 1 (National Coalition for Marine Conservation: Savannah,Georgia, 1989).

Smith, Robert W. *Limits in the Seas*, No. 36, 6th revision (U.S. Department of State: Washington, D.C., January 3, 1990), p. 30.

Sociedad Nacional de Pesca (SONAPESCA), *SONAPESCA Memoria Anual*, 1995, 31p.

Soza-Nishizaki, Oscar. *A study of the Swordfish xiphias gladius stocks in the Pacific Ocean*, Ph.D. thesis, University of Tokyo, Faculty of Agriculture, 1990.

Sosa-Nishizaki, Oscar and Makoto Shimizu. "Spatial and temporal CPUE trends and stock unit inferred from them for Pacific swordfish caught by the Japanese tuna longline fishery," *National Research Institute of far Seas Fihseries Bulletin*, N°28, March 28, 1991, pp. 75-90.

Stengel Meierdicks, Jan. Sociedad Nacional de Pesca, personal communications, July 24, 1997.

Ström, Paul. "Informe al gobierno de Chile sobre la pesca costera con pequeñas embarcaciondes motorizadas." *FAO Informe*, N°2039 (FAO" Rome, 1965), 25p.

Stumptner M., Fernando. "Caldera: Otra vez en la ruta del progreso," *Chile Pesquero*, October, 1986, pp. 27-32.

Sub-Secretarí a de Pesca (SSP). *Chile Azul: Principales Recursos Pesqueros* (ProChile: n Santiago, 1996), 89 p.

_____. *Informe Sectorial Pesquero*, January-March 1997, ISP 02/97 (SSP: Valparaíso, 1997), 10p.

_____. *Informe Sectorial Pesquero: Consolidado, 1996* (SSP: Valparaíso, 1997), 24p.

Suisan Sha. *Suisan Nemkan* (Tokyo: Suisan Sha, 1992), pp. 194-195.

Tobella, G.M. "Observaciones y conclusiones de la temporada de pesca de pez espada de 1967," Tesis, Esc. Cs. del Mar, Unidersidad Católoica de Valparaíso, 1970, 74p.

Tobella, J.M. "La pesquería de pez espada (*Xiphias gladius*) en Chile," Tesis, Esc. Cs. del Mar, Unidersidad Católoica de Valparaíso, 1964, 89p.

Tomczak, Matthias and J. Stuart Godfrey. *Regional Oceanography: An Introduction* (Pergamon: London, 1994), 422p.

Torres, Daniel. "Juan Fernández fur seal, *Arctocephalus philippii*," in "Status, biology, and ecology of fur seals: Proceedings of an International Symposioum and Workshop, Cambridge, England 23-27 April 1984," *NOAA Technical Report*, NMFS51, June 1987. pp. 37-41.

Torres, Daniel, Carlos Guerra, and Michel Sallaberry. "Registros de *Artocephalus australis* en Antofagasta II Región, Chile, y comentarios sobre su distribución geográfica (Pinnipedia: Otariidae)," *Estud. Oceanol.*, Vol 3, No.1, pp. 31-40.

Torres Gutiérrez, Alfredo. "Migraciones de *Trachurus murphyi* en el norte de Chile," *Investigación Pesquera*, Vol. 33, 1986, pp. 99-103.

Tuna Research Center (TRC). *Annual Catch Statistics of Taiwanese Tuna Longline Fishery* (Institute of Oceanography: Taipei, December 1993), (F1-25).

U.S. Embassy, Santiago. Various cables.

Uchiyama, James. NMFS Southwestern Fisheries Science Center, Honolulu, personal communications, October 9, 1997.

Uozumi, Yuji. Distant Water Fishery Research Laboratory (Enyo Suisan Kenkyujo). Personal communications, January 28, February 6 and 28, 1997.

Uribe, Eduardo and Claudio Salazar. "Swordfish (*Xiphias gladius*) catch distributions relative to environmental features observed from satellites off

Coquimbo-Chile (30°S," *Conference for Pacific Ocean Environments & Probing (PORSEC'92 Proceedings)*, Vol. 2, Okinawa Japan, August 25-31, 1992, pp. 851-857.

Vásquez, Julio A. Departamento de Bilolgía Marina, Universidad Catlólica del Norte, personal communications, April 1, 1997.

Vera, Sebastian. Gerente General, Pesquera Omega, personal communications, April 2, 1997.

Viveros Opazo, Eduardo. Director de Fiscalización, Region IV, SERNAP, personal communications, April 7, 1996.

Wadsworth, Peter. Owner/Manager, Pesquera Catalina. Personal communications, December 8, 1995, April 16 and November 12, 1996.

_____. As cited in "Chile's sword landings soar," *Seafood Leader*, Summer 1988, p. 14.

Weidner, Dennis. "Chilean fishing industry, 1987," *International Fishery Reports*, IFR-88/43 (NMFS: Washington, D.C., 1988) 27p.

Weidner, Dennis and David Hall. "Latin America," *World Fishing Fleets*, Vol. IV (NMFS:Silver Spring, Maryland, November, 1993).

Weidner, Dennis and Don Jacobson. "Soviet-Latin American fishery relations," *International Fishery Reports* (IFR-89/39), May 15, 1989.

Wildman, Mark. "Asia," *World Swordfish Fisheries*, Vol. III (NMFS: Silver Spring, 1997).

_____. Wildman, "Japan," *World Swordfish Fishery*, Vol. III, (NMFS: Silver Spring, MD, 1997).

_____. NMFS, Personal communication, January 2, 1996 and January 28, 1997.

Williams, Phil, Paul J. Anninos, Pamela T. Plotkin, and Karen L. Salvini. "Pelagic longline fisher-sea turtle interactions," *NOAA Technical Memorandum*, NMFS-OPR-7, February 1996, 77p.

WorldFish Report, June 19, 1997, p. SP/7.

World Fishing, various issues.

Yabe, *et. al.*, 1959 as cited in I. Nakamura, "Billfishes of the world," *FAO Species Catalogue*, (125) Vol. 5, (FAO: Rome, 1985).*op. cit.*, p. 50.

Yáñez, P. "Peces útiles de la costa chileana," *Rev. Biol. Mar.*, 1955, Vol. VI, No. 1-3, pp. 29-81.

Yáñez, Eleuterio. Universidad Católica de Valparaíso. Personal communicatuions, January 22, 1997.

Yáñez R., Eleuterio. "Estado de situación de la pesqueria del pez espada en Chile," *Boletín Apropech*, No. 16, January-March, 1997, in press.

Yáñez, E., M.A. Barbieri, C. Canales, V. Correa, M. Donoso, A Gozalez, B. Leiva and A. Montiel. "Development and state of art of the Sowordfish Fishery in Chile," paper delivered at the International Symposium on Pacific Swordfish, Ensenada, Mexico, December 11-14, 1994.

Yáñez R., Eleuterio and Marcelo Garcia A. "La pesqueria de pez espada en Chile," *Chile Pesquero*, February-March, 1997, pp. 37-39.

Yáñez, Eleuterio, Maria Angela Barbieri B., Caludio Silva G., and Karen Nieto S. "Temperatura supeficial del mar de satelites NOAA en la pesqueria artesanal de pez espada (*Xiphias gladius*) de la zona central de Chile," *Revista Investigaciones Marinas*, Valparaiso, Vol. 24, 1996.

Yánez R., Eleuterio, Barbieri B., María Angela, Silva G., Claudio and Nieto S.,Karen. "Temperatura supeficial del mar de satélites NOAA en la pesqueria artesanal de pez espada (*Xiphias gladius*) de la zona central de Chile," *Revista Investigaciones Marinas*, Vol. 24, 1996.

Zegarra, José Echandía. General Manager, TRAMARSA (Peru). Personal communications, June 21, 1996.

Zuvic Mujica, Miguel. Chief of Development and Negotiations, Empresa Portuaria de Chile: Coquimbo. Personal communications, April 8, 1996.

ENDNOTES

SECTION I. (Overview)

1 M. Isabela Ortego O., "Reseña general del sector pesquero," *Boletín Informativo SIM*, No. 35, June 1996, p. 1.

2 SERNAP, *Anuario Estadístico de Pesca*, 1996 (SERNAP: Valparaíso, 1997), p. 1.

3 Sub-Secretaría de Pesca (SSP), *Informe Sectorial Pesquero: Consolidado, 1996* (SSP: Valparaíso, 1997), p. 10.

4 SERNAP, *Anuario Estadístico de Pesca*, 1996 (SERNAP: Valparaíso, 1997), p. 1. For details on the Chilean fleet see Dennis Weidner and David Hall,"Latin America" *World Fishing Fleets* (NMFS: Silver Spring, Maryland, 1993).

5 Chile is divided into 12 administrative mainland regions. The regions run from Region I in the north to Region XII in the far south (figure 2). In Chile's highly centralized government, the regions have little real power and are better described as administrative units than states or provinces.

6 Some newer vessels, however, have insulated holds and can carry ice to preserve the quality of the catch. Marco News release, September 20, 1993.

7 Sociedad Nacional de Pesca (SONAPESCA), *Memoria Anual*, 1995, p. 23. The SONAPESCA report provides considerable detail on changes in the Chilean fleet. Current data on the fleet is also available in Sub-Secretaría de Pesca, *Informe Sectorial Pesquero: Consolidado, 1996* (SSP: Valparaíso, 1997), 24p.

8 Carlos Capurro, Economic Section, U.S. Embassy, personal communications, September 16, 1993. The Embassy's estimate includes both the pelagic and trawl fleet.

9 Ley de Pesca, ley N° 18.892, article 3. Vessels can only be replaced by other vessels with equal or smaller capacity. Alejandro Covarrubias Pérez, Jefe, Departamento Administración Pesquera, Servicio Nacional de Pesca, personal communications, October 13, 1993.

10 Argentine companies have acquired larger trawlers in recent years which they deploy in groundfish fisheries, sometimes at considerable distance from port.

11 Richard Parrish, "Trip report for Richard Parrish's (PFEL) visit to Chile to attend an international meeting sponsored by the IFOP and held in Valparaíso, Chile on May 5-7, 1997," May 28, 1997.

12 El Niño events can fluctuate significantly in a short period of time. NOAA climatologists continue to predict an especially severe 1997-98 El Niño. One expert believes the current El Niño is at least on the order of magnitude of the massive 1982-83 El Niño. Ants Leetma, presentation on El Niño at the NOAA Climate Change Board, August 20, 1997. Significant connections to mid ocean latitudes are expected to persist through at least April 1998. Timely information on the current event, including SST forecasts, is available on the ENSO web site at: http://www.ogp.noaa.gov/enso/

13 FAO has a standardized statistical system so that the catches of different countries can be compared.

14 SERNAP, *Anuario Estadístico Pesquero, 1996* (SERNAP: Valparaíso, 1997), p. 194.

15 Sub-Secretaría de Pesca (SSP), *Informe Sectorial Pesquero*, January-March 1997, ISP 02/97 (SSP: Valparaíso, 1997), p. 1.

16 "Fishmeal stocks to fall on lower production," *WorldFish Report*, June 19, 1997, p. SP/7. While mackerel catches have declined, the overall fall in catches has been somewhat offset by increased anchovy catches. The anchovy stock off southern Peru and northern Chile has apparently shifted south during 1997 because of the warming water temperatures. Jan Stengel Meierdicks, Sociedad Nacional de Pesca, personal communications, July 24, 1997.

17 Chilean companies through July 1997 are reporting sharply lower catches of jack mackerel, a decline of about 1 million t from 1996 levels. The falling catch has only partially offset by higher anchovy catches. The decline will be much larger for the full year, especially if--as some are expecting, the 1997 El Niño intensifies. Stengel Meierdicks, *op. cit.* July 24, 1997.

18 SONAPESCA, *SONAPESCA Memoria Anual*, 1995, *op. cit.*, p. 24. Precise catch data by region for each species is available in SERNAP, *Anuario Estadístico de Pesca*, *op. cit.*

19 SONAPESCA, *SONAPESCA Memoria Anual*,1995, *op. cit.*, p. 23.

20 An excellent review of Chilean fishery resources is available in Sub-Secretaría de Pesca (SSP), *Chile Azul: Principales Recursos Pesqueros* (ProChile: Santiago, 1996), 89 p.

21 A good brief description of Chile's management system is available in SONAPESCA, *SONAPESCA Memoria Anual*, 1995, *op. cit.*, pp. 28-29.

22 Patricio Bernal, Subsecretario de Pesca, comments at FAO Committee on Fisheries session, Rome, Italy, March 14-15, 1995. Also see Harlan C. Lampe, "Fisheries management in Chile: Aspects of the law and examples of its application," *Fisheries Management: Global Trends* (University of Washington: Seattle, June 14-16, 1994) and "Law's complex passage ...," *Fishing News International*, February 1991, Chile supplement, p. 3.

23 "ExpoPESCA '96" report," *Fishing News International*, March, 1997.

24 SSP, *Informe Sectorial Pesquero: Consolidado, 1996*, *op. cit.*, p. 4.

25 The declining investment may have, at least in part, been due to the uncertainty associated with delays in passage of a new fisheries law. U.S. Embassy, Santiago, September, 1991. The passage of the law in late 1991, however, stimulated substantial new investment. San Antonio, for example, a multi-purpose port 110 km west from Santiago with a sharply declining economy was being renovated to become a major fisheries center. About half of the new investment in the Chilean fishing industry during 1993 and 1994 was being directed at San Antonio. About a third of the new investment is for seven new fishmeal plants had to be in operation by September 1993, a deadline established in the transitory article of the 1991 Ley de Pesca. The investment include modern fishmeal processing equipment, capable of producing "high-quality" meal, as well as pollution control equipment. The remainder of the investments in San Antonio are primarily being directed at new vessels to supply the 1.0-1.5 million t of fish needed to supply the new plants. The total requirements of the plants is 700-1,000 t of raw material per hour. Carlos Capurro, U.S. Embassy, personal communication, September 16, 1993.

26 The Chilean Congress is currently considering an environmental framework law. If and when passed, such legislation will probably require the fishing industry to make major investments in pollution control systems. Many Chilean fishing companies currently have only minimal systems to treat waste water. Addressing this problem may take a large share of any new investment in the fishing industry for the next few years. The proposed environmental legislation is currently being discussed in the Senado after being approved by the Cámara de Diputados. Carlos Capurro, U.S. Embassy, Santiago, September 13, 1993.

27 SSP, *Informe Sectorial Pesquero: Consolidado, 1996,* op. cit., p. 23.

28 Stengel Meierdicks, *op.cit.*, July 24, 1997 and SSP, *Informe Sectorial Pesquero: Consolidado, 1996*, *op. cit.*, p. 8.

29 SONAPESCA, *SONAPESCA Memoria Anual*, 1995, *op. cit.*, pp. 26-27.

30 SSP, *Informe Sectorial Pesquero: Consolidado, 1996*, *op. cit.*, p. 22.

31 "Massive pressure to enlarge fleet," *Fishing News International*, February 1991, p. 2. For details on the Chilean fleet see Weidner and Hall, "Latin America," *op. cit.*, p. 310.

32 "Chile expands production base," *Seafood International*, March, 1994, p. 25.

33 Domestic demand declined sharply in 1995, but recovered somewhat to about 295,000 t in 1996. SSP, *Informe Sectorial Pesquero: Consolidado, 1996* (SSP: Valparaíso, 1997), p. 24.

34 Capurro, *op. cit.*, September 16, 1993.

35 For details on Soviet fishing operations off Chile and other Latin American countries, see Dennis Weidner and Don Jacobson, "Soviet-Latin American fishery relations," *International Fishery Reports* (IFR-89/39), May 15, 1989.

36 Chilean companies in 1996 operated nearly 100 vessels with carrying capacities of 850-1,099 tons and over 45 vessels in excess of 1,100 tons. In 1990, only a handful of such large vessels were deployed. SSP, *Informe Sectorial Pesquero: Consolidado, 1996*, *op. cit.*, p. 10.

37 See William Folsom, "Fisheries of Chile, 1971," *Foreign Fisheries Leaflet*, FFL 73-21 (NMFS: Washington, D.C., 1973) 17p and Dennis Weidner, "Chilean fishing industry, 1987," *International Fishery Reports*, IFR-88/43 (NMFS: Washington, D.C., 1988) 27p.

38 "Fishing industry must expand markets," *Chile Economic Report*, July, 1993, pp. 6-7 and Manuel Achurra L., "El intenso esfuerzo para conquistar mercados externos," *Chile Pesquero*, April-May, 1994, pp. 17-24.

39 SSP, *Informe Sectorial Pesquero*, January-March 1997, *op. cit.*, p. 1 and Stengel Meierdicks, *op. cit.*, July 24, 1997.

40 SONAPESCA, *SONAPESCA Memoria Anual*, 1995, *op. cit.*, pp. 25-26.

41 SSP, *Informe Sectorial Pesquero*, January-March 1997, *op. cit.*, pp. 4-5.

SECTION II. (Species)

42. The only other important research work known to the authors is underway in Brazil and Venezuela. For details see the Brazilian and Venezuelan chapters of this study.

43. R.A. Skillman, "Status of Pacific billfish stocks," in R.H. Strod (ed.) *Proceedings of the Second International Billfish Symposium*, Kaila-Kona, Hawaii, August 1-5, 1988, Part 1 (National Coalition for Marine Conservation: Savannah,Georgia, 1989).

44. Norman W. Bartoo and Atilio L. Coan, Jr., "An assessment of the Pacific swordfish resource," in R.H. Strod (ed.) *Planning the Future of Billfishes: Research and Management in the 1990s and Beyond*, Part 1 (National Coalition for Marine Conservation: Savannah, Georgia, 1989), pp. 137-151. The Coalition's publication was the *Proceedings of the Second International Billfish Symposium*, held at Kaila-Kona, Hawaii, August 1-5, 1988.

45. Yuji Uozumi, Distant Water Fishery Research Laboratory, personal communications, February 6, 1997.

46. D. Bedford and F. Hagerman, "The billfish fishery resources of the California Current," *CALCOFI Report*, 1983, Vol. XXIV, pp. 70-78.

47. Oscar Sosa-Nishizaki, *A Study of the Swordfish Xiphias gladius Stocks in the Pacific Ocean*, Ph.D. thesis, University of Tokyo, Faculty of Agriculture, 1990.

48. G.T. Sakagawa, "Trends in fisheries of swordfish in the Pacific Ocean, in R.H. Strod (ed.) *Proceedings of the Second International Billfish Symposium*, Kaila-Kona, Hawaii, August 1-5, 1988, Part 1 (National Coalition for Marine Conservation: Savannah,Georgia, 1989).

49. Michael G. Hinton and Richard B. Deriso, "Structure and assessment of stocks of swordfish in the eastern Pacific Ocean," *Sustaining Tuna Fisheries--Issues and Answers*, Proceedings of the 47th Tuna Conference, Lake Arrowhead, California, May 20-23, 1996.

50. Richard Parrish, "Environmental variations and the validity of stock assessment of highly migratory species," paper delivered at the Second International Swordfish Symposium, March 4, 1997, Turtle Bay, Oahu, Hawaii.

51. González, Barbieri, and Yáñez, "Distribución espacio temporal ...," *op. cit.*

52. The Japanese, for example, were primarily targeting bigeye and notably there is also a southeastern cluster of high bigeye catches in the southeastern Pacific. The southeastern bigeye cluster, however, does not appear as prominent as the swordfish cluster. Fabio Carocci and Jacek Majkowski, *Pacific Tunas and Billfishes: Atlas of Commercial Catches* (FAO: Rome, 1996), maps 3 and 13.

53. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, maps 9-11. This concentration did not show in the data presented for 1962-64 (map 8). The authors of this study have decided to exclude the 1962-64 data, because foreign fishing had not yet approached the southern Peruvian or the Chilean coast and thus did not cover an important section of the southeastern Pacific. In addition, swordfish catches in many oceanic areas of the southeastern Pacific during 1962-64 were much lower than during what the authors believe are the more representative years presented for the 1970s, 80s, and 90s (maps 9-11). The Carocci and Majkowski study did not include swordfish catches taken by Peruvian and Chilean fishermen, which in some years were substantial. Chilean artisanal and commercial fishermen during the early 1990s, for example, landed very substantial quantities of swordfish. See the catch section in the Chilean and Peruvian chapters of this report for details. Carocci and Majkowski are planning a future edition of their atlas with additional data from artisanal fisheries, or in the case of Chile with data from both artisanal and commercial fisheries. Jacek Majkowski, Department of Fisheries, FAO, personal communications, April 7, 1997.

54. See figure 1 displaying the geographic distribution of swordfish catches in Yuji Uozumi and Kotaro Yokawa, "Country report for the swordfish fisheries in the Pacific Ocean," paper delivered at the Second International Swordfish Symposium, March 3, 1997, Turtle Bay, Oahu, Hawaii, p. 6.

55. Oscar Sosa-Nishizaki and Makoto Shimizu, "Spatial and temporal CPUE trends and stock unit inferred from them for Pacific swordfish caught by the Japanese tuna longline fishery," *Bulletin of the National Research Institute of Far Seas Fisheries*, No. 28, March 1991, pp. 80-85.

56. See the Peruvian chapter of this report for details.

57. Sosa-Nishizaki and Shimizu, "Spatial and temporal CPUE trends ...," *op. cit.*, pp. 80-85; Uozumi and Yokawa, "Country report ...," *op. cit.*, p. 6.; and Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13.

58. Currently most of the South American catch of swordfish is taken off Chile. Peru conducted an important swordfish fishery in the 1940s-50s. Domestic catches are currently limited, but some companies are planning to enter the fishery. There has, however, been some foreign fishing in Peruvian waters. The Ecuadorean longline fleet has focused on tuna, but in recent years the Government has reported increasing swordfish catches. For details see the individual country chapters of this report.

59. The Spanish are not reporting their catches to FAO so no catch data is available to plot (appendix E5). Available anecdotal reports suggest operations off southern Peru and central Chile, but some operations as far north as Ecuador. Echeandía Zegarra, *op. cit.*, June 21, 1996; Schmidt, *op. cit.*, April 8, 1996; and Salas, *op. cit.*, August 26, 1997. This is confirmed by available Chilean Navy data (appendix D4). See "Fishing Grounds" and "International" for a more detailed discussion of the grounds targeted by the Spanish. The Spanish grounds are also assessed in the Peruvian chapter of this report because the Spanish longliners operate out of Ilo and other Peruvian

ports. Also see the Spanish chapter of this report for information on the overall Spanish swordfish effort.

60. See the Ecuadorean chapter of this report for details.

61. Distinct seasonal patterns in the southern area of the southeastern Pacific are due to more pronounced climatic variations then in equatorial areas.

62. Data on the seasonality reported by foreign fishermen at tropical latitudes, showing good results during the first quarter in many areas, is available in Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13. Chilean seasonal data. however, show that little swordfish is taken at the beginning of the year (appendices E2c1-2 and E2d1-2).

63. See the Colombian and Ecuadorean chapters of this report for a fuller discussion of the pattern in tropical waters.

64. Patricia E. Rosal and Barbara A Block, "Mitochondrial control region variability and global population structure in the swordfish, *Xiphias gladius*," and Barbara A. Block, "Progress report as of June 1995: Analysis of swordfish population structure using mitochondrial and nuclear DNA technologies," internal annual report for the Pelagic Fisheries Research Program at the University of Hawaii. Subsequently after analyzing the samples, Block and her associates found very significant genetic differences.

65. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13. Even in the many areas where swordfish are not reported in the above source, they may actually be present. The southeastern Pacific data used in compiling the atlas came primarily from directed fisheries for bigeye and other tunas in which swordfish was only a by-catch. Thus the fishermen may have avoided some areas, especially in temperate waters, where bigeye yields were low. This does not mean that swordfish were not present.

66. There are, however, other explanations. Researchers report that gene flows among Pacific swordfish can be explained in two ways. "Either the recent history of swordfish in the Pacific masks population subdivision which truly exists, or there may indeed be very high levels of adult migration between contemporary populations." Carol Reeb, Loretta Arangeli, and Barbara Block, "Using mitochondrial DNA sequence and microsatellite loci to examine population structure in Pacific swordfish," *Sustaining Tuna Fisheries--Issues and Answers*, Proceedings of the 47th Tuna Conference, Lake Arrowhead, California, May 20-23, 1996.

67. Rosal and Block, "Mitochondrial control ...," *op. cit.*

68. José M. Grijalva-Chon, Jorge de la Rosa-Vélez, and Oscar Sosa-Nishizaki, "Allozyme variability in two samples of swordfish, *Xiphias gladius L.*, in the North Pacific Ocean," *Fishery Bulletin*, Vol. 94 No. 3, 1996, pp. 589-594.

69. Carol Reeb and Barbara Block, "Genetic analysis of Pacific swordfish populations using mtDNA and microsatellite markers," paper delivered at the Second International Swordfish Symposium, March 5, 1997, Turtle Bay, Oahu, Hawaii.

70. Naritoshi Cho, "An attempt to clarify genetic stock structure of swordfish using nuclear gene markers," paper delivered at the Second International Swordfish Symposium, March 5, 1997, Turtle Bay, Oahu, Hawaii.

71. This may be the case off the U.S. Atlantic coast where data collected from the swordfish fishery appears to suggest that the fish may be following the Gulf Stream north along the coast. Jean Crammer, "Large pelagic logbook newsletter-1994," *NOAA Technical Memorandum*, NMFS-SEFSC-378, November 1995 and Jean Crammer, "Large pelagic logbook newsletter-1995," NMFS-SEFSC-394, November 1996.

72. Oceanographers are increasingly using the term "Chile" or "Peru" Current instead of the Humboldt Current. As this study describes the swordfish fishery off Chile, Peru, Ecuador, and Colombia, the authors concluded that the term Chile or Peru Current might be confusing. In addition, in deference to the many Chilean and Peruvian who assisted in this project, the authors did not want to select either the "Chile" or "Peru" Current.

73. See for example low mean temperatures running north off the Pacific coast of South America, even at equatorial latitudes. Sydney Levitus and Timothy P. Boyer, "Temperature" *World Ocean Atlas, 1994*, Vol. IV (Washington, D.C.: NOAA/NESDIS, June 1994), pp. 45-46. The low temperatures, however, are not entirely due to the Humboldt Current, but also reflect upwelling.

74. See for example Guillermo Podesta, "Aspects of swordfish oceanography in the Atlantic," Second International Pacific Symposium, Turtle Bay, Hawaii, March 4, 1997.

75. Eceandía Zegarra, *op. cit.*, June 21, 1996; Pastor, *op. cit.*, June 3, 1997; Salas, *op. cit.*, August 26, 1997, and Schmidt, *op. cit.*, April 4, 1996.

76. Sosa-Nishizaki and Shimizu, "Spatial and temporal CPUE trends ...," *op. cit.*, pp. 80-85 and Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13.

77. Miguel Donoso and Rodolfo Serra, *La pesquería de pez espada en Chile*, (IFOP: Valparaíso, 1997), p. 2.

78. Chong, *op. cit.*, December 4, 1996. Barbara Block is also running genetic tests on Chilean swordfish which may eventually help determine the relationship of the fish off Peru to the fish off Chile. For details of the overall research project see Block, "Progress report ...," *op. cit.*

79. Peruvian fishermen reported very sizeable catches of swordfish in the late 1940s and early 1950s (Peru, appendix B1). There was some similarity in Peruvian and Chilean catch trends during the 1940s and early 1950s. Chilean fishermen also reported a substantial increase in the swordfish fishery, peaking at 2,100 t in 1946 (appendix E2a), a few years earlier than the peak of the Peruvian fishery. Peruvian catches by the 1990s, however, had fallen to very low levels. It is unclear what caused this decline. It could reflect a significant change in swordfish abundance off Peru. A more likely reason for the declining catches are economic and social factors. The Peruvian fishery was a labor-intensive harpoon fishery of declining profitability. Unlike Chilean fishermen, Peruvians have not yet significantly deployed modern gear such as driftnets and longlines for swordfish. Without fishery or stock assessment data, it is not possible to determine the situation off Peru.

80. See the Peruvian chapter of this report for details.

81. See the Peruvian chapter of this report for details.

82. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13, Uozumi and Yokawa, "Country report ...," *op. cit.*, p. 6, and Sosa-Nishizaki and Shimizu, "Spatial and temporal CPUE trends ...," *op. cit.*

83. S. Kip Farrington, Jr., *Fishing the Pacific: Offshore and On* (New York: Coward-McCann, 1953).

84. Commercial fishermen through 1995 had conducted substantial operations on the fringe of the Chile's 200-mile zone, but generally within it. The fishery in 1996 shifted effort largely outside Chilean waters where nearly 90 percent of the catch was taken.

85. Ecuadorean fishermen conduct a small longline fishery which has primarily targeted tunas. Reports from Ecuador, however, suggest that beginning in 1996, increased attention is being given to swordfish. For details see the Ecuadorean chapter of this report. The Ecuadorean catches, however, are only a fraction of the large Chilean catch. Colombian and Peruvian catches through 1996 are minimal.

86. For information on the stock structure gleaned from fisheries conducted by distant-water and coastal countries to the north of Chile, see the individual chapters for those countries.

87. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13 and Uozumi and Yokawa, "Country report ...," *op. cit.*, p. 6.

88. For ease of reference the authors will refer to 19°S as the Peruvian/Chilean marine border.

89. A. Gonzalez, M.A. Barbieri, and E. Yáñez, "Distribución espacio temporal de la pesquería artisanal de pez espada (Xiphias gladius) y variaciones ambientales en la zona de Valparaíso," *XII Jornadas de Ciencias del Mar*, May 27-29, 1992.

90. Eduardo Reyes F., "Pesquería y mercado del pez espada," *Chile Pesquero*, July-August 1988, pp. 30-31.

91. Lizama and Naranjo, "Utilización del palangre ..., " *op. cit.*, p. 45.

92. The limited range of the artisanal fishermen should not be overstated. The Chilean artisanal vessels are not dugout canoes making day trips, but semi-commercial vessels. (See "Fleet".) These vessels can make trips of several hundred kilometers and land their catch and some distance from the fishing grounds.

93. Chilean fishermen have been becoming increasingly sophisticated at finding swordfish as the fishery has developed since 1986. The fishermen now appear to be fully exploiting, if not over exploiting, the resource. (See "Species: Stock status.") As a result, the current catch pattern is probably a good general reflection of the geographic distribution and seasonal occurrence of swordfish off Chile, especially for the sizes targeted. It should be stressed, however, that a variety of factors affect fishing operations, including economic considerations. Commercial fishermen, for example, have reduced effort on their offshore grounds during recent years--even though swordfish are almost always present in the northern offshore zone (Zone 1). Some of the fishermen report that while swordfish are available, they are mostly juveniles and it is not profitable to target such small fish. H. Schmidt, *op. cit.*, April 8, 1996.

94. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13; Sosa-Nishizaki and Shimizu, "Spatial and temporal CPUE trends ...," *op. cit.*, pp. 80-85; and Nakano, "Stock status of swordfish ...," fig. 2.

95. Foreign longline data, for example, also shows a southeastern Pacific cluster of high catches, similar the swordfish cluster. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, maps 3 and 13.

96. Fishermen following the fish is a logical conclusion, but many other factors are involved. Artisanal harpoon fishing was not a full-time occupation. The fishermen fished swordfish for part of the year and then shifted seasonally to other species. Thus developments in these fisheries could have affected the shift to ports along the central coast. Many other factors such as job opportunities in other economic sectors could have also been involved as overall declining effort accompanied the shift south.

97. Donoso and Serra, "La pesquería ...," *op. cit.*, p. 2.

98. C. Oliver, "Catálogo de los peces marinos del litoral de Concepción y Arauco," *Bol. Soc. Biol. Concepción*, Vol. XVII, 1943. The findings off the central coast do not necessarily mean that the fish were more abundant off the central coast. More likely it reflects the larger population compared to the arid, barren north (photo 34).

99. "Growing fresh and frozen catch: 1,000 boats on swordfish," *Fishing News International*, April 1992, p. 31.

100. Sosa-Nishizaki and Shimizu, "Spatial and temporal CPUE trends ...," *op. cit.*, pp. 80-85.

101. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13 and Uozumi and Yokawa, "Country report ...," *op. cit.*, p. 6.

102. No Japanese fishing vessels entered Chilean waters during 1996 and 1997. Chilean Navy, unpublished data, *op. cit.*, July 22, 1997. almost certainly there would have been some port calls if large numbers of vessels were present.

103. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13 and Nakano, "Stock status of swordfish ...," fig. 2.

104. In oceanic areas (west of 100°W) there is limited foreign fishing south of 15°S and no fishing south of 25°S. Closer to the Chilean coast (70-100°W) there is limited fishing south of 25°S and no fishing south of 35°S. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13.

105. Salas, *op. cit.*, August 26, 1997.

106. José Echeandía Zegarra, TANSMARSA (Peru), personal communications, June 21, 1996 and Hans Louis Schmidt, General Manager, Pesquera Omega, personal communications, April 8, 1996.

107. Chilean Navy, unpublished data, *op. cit.*, July 22, 1997. The Chilean Navy report indicates at what latitude the Spanish vessels entered Chilean waters. This is presumably a reflection of the latitudes at which they were operating, but provides no information at what longitude (appendix D4). For details on the Spanish fishery, see "International" and the Peruvian chapter of this report.

108. Salas, *op. cit.*, August 26 and September 1, 1997.

109. The factors explaining why Peruvian fishermen have not initiated a longline fishery targeting either tuna or swordfish are discussed in the Peruvian chapter of this report.

110. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13 (foreign longline data); Uozumi and Yokawa, "Country report ...," *op. cit.*, p. 6 (Japanese longline data); and Salas, *op. cit.*, August 26, 1997 (Chilean longline fishing).

111. For details see the Argentine chapter of this report.

112. For details on Peru see the Peruvian chapter of this report.

113. Farrington, *Fishing the Pacific*, *op. cit.*, p. 8.

114. Captain Defeo described his failure to find swordfish off the northern coast, but better success out of Algarrobo. His time to pursue fishing out of Algarrobo was limited. Rick Defeo, presentation at the United States-Chilean Cooperative Fishery Talks, July 24, 1997. One observer indicated that part of the reason that Captain Defeo encountered difficulties finding swordfish was that he was not fishing during the peak season. Rodolfo Serra, IFOP, presentation at the United States-Chilean Cooperative Fishery Talks, July 25, 1997.

115. Richard Schaefer, "Trip Report," Chilean trip, November 17-28, 1996, December 24, 1996 and Alejandro Covarrubias, Departamento de Fiscalización, "Infrastructura de apoyo a la pesca deportiva marina en Chile," (SERNAP: Valparaíso, 1996), 25p.

116. Swordfish tagging studies have proven difficult to conduct. Unlike other billfish, there is very limited sports fishing for swordfish. Thus the tag and release fishing campaign among sports fishermen that has provided extensive tag returns for other billfish has proven of little value for swordfish. Commercial and artisanal fishermen are much less likely to land live fish and the economic cost of releasing the fish makes it a very expensive proposition.

117. Researchers in the north Pacific have begun to report scattered returns of swordfish tags. This is supplemented somewhat by swordfish recoveries off California with the hooks U.S. fishermen use off Hawaii. The authors know, however, of no tagging effort off Chile.

118. Large fish were being taken along the central coast during 1988 while only 50-60 kg fish were being taken off Caldera. Reyes, "Pesquería y mercado ...," *op. cit.*, p. 32.

119. Francisco Ponce Martínez and René Bustos, "La pesquería de pez espada *Xiphias gladius* Linnaeus, 1758 en Chile," *Revista Pacífico Sur*, No. 19, 1991, p. 25. Paper presented at the Regional Seminar on the Evaluation of Resources and Artisanal Fisheries.

120. Javier Chong Lay-Son, Universidad Católica de Sma. Concepción, personal communications, April 23, 1997.

121. Barbieri, *et. al*, "La pesquería de pez espada ...," *op. cit.*, p. 207.

122. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13.

123. Barbieri, *op. cit.*, December 19, 1996.

124. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13.

125. Donoso and Serra, "La pesquería ...," *op. cit.*, pp. 4-5.

126. The authors note that the beginning of the artisanal catch has shifted since the fishery began. Some catches were initially reported in February and the fishery began in earnest during March (1985-89). During the early 1990s (1990-94) the fishery began in March. In the past few years (1995-96) only limited caches were reported in March and significant landings did not begin until April (appendices E3a1-2).

127. Clavería, *op. cit*, April 12, 1996.

128. Barbieri, *op. cit.*, December 19, 1996.

129. Maria Angela Barbieri, Jefe, Departamento de Tecnologia Pesquera, IFOP, personal communications, April 12, 1996 and H. Schmidt, *op. cit.*, April 8, 1996.

130. Artisanal results are the best indicator of the presence of swordfish in coastal waters. Commercial operations which are conducted at greater distances from the coast, however, show similar results with the lowest landings from November to January/February (appendix E4a1-2), suggesting that the fish are also not abundant on Chile's offshore grounds.

131. H. Schmidt, *op. cit.*, April 8, 1196.

132. IFOP continues to collect data and seasonal patterns may become more apparent when longer time-line data is available.

133. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994." *op. cit.*, pp. 15-16.

134. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13.

135. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13.

136. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13.

137. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13.

138. M. A. Barbieri, M. Donoso, A. Gonzalez, V. Correa, B. Leiva, and A. Montiel, "Development and state of art of the swordfish fishery in Chile", paper delivered at the International Symposium on Pacific Swordfish, Ensenada, B.C., Mexico, December 11-14, 1994, figure 10.

139. Izumi Nakamura, "Billfishes of the World," *FAO Species Catalog/FAO Fisheries Synopsis* (FAO:Rome, 1985), p.49.

140. J.M. Tobella, "La pesquería de pez espada (*Xiphias gladius*) en Chile," Tésis, Esc. Cs. del Mar, Universidad Católica de Valparaíso, 1964, 89p. and G.M. Tobella,"Observaciones y conclusiones de la temporada de pesca de pez espada de 1967," Tesis, Esc. Cs. del Mar, Universidad Católica de Valparaíso, 1970, 74p. as cited in Barbieri, *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 196.

141. J.S. Beckett, "Biology of swordfish, *Xiphias gladius*, L. in the Northeast Atlantic Ocean," in R.S. Shomura and F. Williams, ed. *Proceedings of the International Billfish Symposium*, Hawaii, August 9-12, 1972, part 2, pp. 103-106.

142. Nakamura, "Billfishes of the World," *op. cit.*, p. 49.

143. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 207.

144. Salas, *op. cit.*, August 26, 1997.

145. Salas, *op. cit.*, August 26, 1997.

146. The fishermen tend to look for areas where there is a temperature gradient of about 1°C around waters of these temperatures. Barbieri, *op. cit.*, December 19, 1996.

147. The authors reported lower 1994 artisanal yields during March-April, but improved yields during May-July as the water cooled. The authors note that the May-July period also corresponded to the peak of the jack mackerel fishery. Yáñez, *et. al.*, "Temperatura superficial ...," *op. cit.*

148. Vernon Kousky, Climate Analysis Center, National Weather Service, NOAA, personal communications, December 17, 1996.

149. The Pacific Equatorial Zone since March 1997 began to experience strong El Niño conditions. Sea surface temperatures (SSTs) in the central and eastern zones have risen and currently rival those measured during the massive 1983 El Niño event which was the strongest El Niño since modern records have been kept. The event is clearly registered by a large negative value of the ENSO (climatic) index that has persisted over several months. It is also evident in the anomalous depth of the thermocline at the equator and has been observed in sea level changes (Kelvin waves traveling west to east). The warming has spread both north and south along the coast of South America and in localized places the SST anomalies exceed 4°C. There have been numerous anecdotal reports of impact upon various fisheries. The timing of this event is unusual in that El Niño events more typically occur during the late fall and early winter, explaining the term "El Niño" which refers to the Christ child in Spanish. A few of the five or so El Niño forecasting models predicted this event but the early timing of it was a surprise to many. Predictions as of August 1997 indicated that it would be strong during the later months of 1997 and into the first month or so of 1998. Modelers generally concede that mid-year conditions are less predictable. Large positive SST anomalies have persisted in the eastern north Pacific (off the North American west coast) throughout May and June. These are largely attributable to the effects of large-scale barometric pressure and wind anomalies over the north Pacific that are typical of El Niño events. The actual broadcast of energy events from the tropics northward and southward along the coast are difficult to ascertain because of insufficient monitoring of subsurface conditions. A CalCOFI survey undertaken in June 1997 reported that the warming is restricted to a shallow surface layer, a strong coastal undercurrent (often produced by equatorial events) is not present, and SST anomalies may be lessening from their peak values. Northern hemisphere summer reversals of these events have been recorded before only to have the warming blossom again in the latter part of the year. NOAA specialists expect that large-scale warming off the Canadian, United States, and Mexican (Baja) coast will occur in November 1997 through February 1998. There have been numerous reports of semi-tropical fishes caught by sports fishermen all the way north to the Oregon Coast (45°N). The catches of albacore tuna along the California coast began more than one month early. Salmon fishermen have reported salmon feeding heavily on numerous large schools of sardines in the Pacific Northwest. The long term effects of this late spring warming upon particular fish populations are difficult to assess. Ronald Lynn, NMFS Southwest Fisheries Science Center, material prepared for the United States-Mexican Fishery Cooperation Talks, September 3-5, 1997. Latin American sources are reporting similar impacts on fisheries in the southern hemisphere during mid-1997. Peruvian sources report a major decline in the anchovy fishery. Pastor, *op. cit.*, June 3, 1997 and Parish, "Trip report ..., *op. cit*, May 28, 1997. Chilean sources report a major decline in the jack mackerel fisheries. Stengel Meierdicks, *op. cit.*, July 24, 1997. Peruvian sources reported unusual catches of swordfish and other billfish. "'Gigantes del mar' frente al Callao," *El Comercio*, June 1, 1997 and *Diario el Sol*, June 15, 1997.

150 See the Peruvian chapter of this report for details.

151. National Oceanographic and Atmospheric Administration (NOAA). The El Niño Southern Oscillation (NSO) web site can be found at: http://www.ogp.noaa.gov/enso/

152. Eleuterio Yáñez R. and Marcelo Garcia A., "La pesquería de pez espada en Chile," *Chile Pesquero*, February-March, 1997, pp. 37-39.

153. Nakamura, "Billfishes ...," *op. cit.*, p.50.

154. Joseph, Bayliff, and Hinton, "A review ...," *op. cit.*, p.2.

155. Nakamura, "Billfishes ...," *op. cit.*, p.50.

156. For more details see Wildman, "Asia," *World Swordfish Fisheries*, *op. cit.*

157. Nakamura, "Billfishes ...," *op. cit.*, p.50.

158. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 28.

159. Chilean researchers using samples provided by artisanal fishermen found females in the process of maturation (vitelogenico) from April (5 percent) through November (65 percent), but only found mature fish during September. J. Chong, J.R. Galleguillos, R. Gonzalez, and M. Donoso,"Projecto: Estudio del proceso reproductivo, fecundidad y marcadores genéticos en el pez espada (*Xiphias gladius*, Linneo), Universidad de Concepción, 1996, summary provided by Chong, *op. cit.*, April 23, 1997.

160. Barbieri, *op. cit.*, March 4, 1997.

161. For details see the individual country chapters, especially Colombia, Ecuador, and Peru. U.S. researchers have also not found swordfish in plankton studies along the coast of California, Oregon, and Washington. The absence of swordfish in the extensive CALCOFI plankton record is especially notable.

162. For details see the Ecuadorean chapter of this study.

163. The most comprehensive Pacific study of oceanic fish larvae has been conducted by the Japanese National Research Institute of Far Seas Fisheries (NRIFSF). Researchers with the NRIFSF failed to find any swordfish larvae east of 108°W, although they did not test waters south of 12°S. Nisikawa, Honma, Yueyanagi, and Kikawa, *Average Distribution of Larval Oceanic Species of Scombroid Fishes, 1956-81* (Far Seas Fisheries Research Laboratory: Shimizu, Japan, 1985), Series S No. 12. Other larval studies have included: CALCOFI, EASTROPAC I and II, and the Soviets R/V *Akademik Kurchatov* (cruise 17). They have all failed to find swordfish larvae east of 108°W. While these surveys were not designed specifically for swordfish, they did encounter larvae of similar species (such as frigate mackerel and sailfish). If swordfish larvae had been present, they would have presumably also have encountered it. Larvae of several other oceanic species such as bigeye and yellowfin tuna were also absent or extremely rare. Researchers are unsure as to why spawning of these oceanic species does not appear to be taking place in the ETP--despite appropriate temperatures and salinities. Robert Humphreys, "Review of larvae and juvenile distributions with inference towards spawning habitat," paper delivered at the Second International Swordfish Symposium, March 5, 1997, Turtle Bay, Oahu, Hawaii.

164. Farrington, *Fishing the Pacific, op. cit.*, pp. 15-16 and H. Schmidt, *op. cit.*, April 8, 1996.

165. Barbieri, *op. cit.*, December 19, 1996.

166. Chong, *op. cit.*, December 4, 1996.

167. Clara Munita O., "De los moais al desarrollo pesquero: ¿Un abismo insuperable," *Chile Pesquero*, November-December, 1987, pp. 27-31.

168. Yabe, *et. al.*, 1959 as cited in Nakamura, *op. cit.*, p. 50.

169. This is widely accepted by most swordfish researchers, although some anomalies have been noted among Mediterranean fish.

170. Chong *et. al.*, "Projecto: Estudio del proceso reproductivo ...," *op. cit.*

171. The annual fluctuations may be due in part to significant fluctuations in effort deployed. This has been especially true in recent years as many vessels have been withdrawn from the fishery.

172. Cristóbal Anusch, Controller, Pesquera Omega, personal communications, November 21, 1995. Other observers report that the largest fish are reported at the beginning of the season off the central coast. Barbieri, *op. cit.*, December 19, 1996.

173. Gastón Clavería, SERNAP Provincial Director, San Antonio, personal communications, April 12, 1996.

174. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 207.

175. For details on the driftnet fishery see: M. Angela Barbieri, Eleuterio Yáñez R., Luis Ariz A., Antonio González C., "La pesquería del pez espada: Tendencias y perspectivas," in *Perspectivas de la Actividad Pesquera en Chile* (Escuela de Ciencias del Mar, UCV: Valparaíso, Chile, 1990), p. 207 and Barbieri *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, pp. 17-18.

176. Hans Louis Schmidt, General Manager, Pesquera Omega, personal communications, April 8, 1996.

177. SERNAP, *Anuario Estadístico de Pesca*, various years. A discussion of more detailed effort, catch and yield monthly data for 1994-95 is available in Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, pp. 14-19.

178. H. Schmidt, *op. cit.*, April 8, 1996.

179. Barbieri, *op. cit.*, December 19, 1996.

180. Barbieri, *op. cit.*, January 29, 1997.

181. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13 and Uozumi and Yokawa, "Country report ...," *op. cit.*, p. 6.

182. This pattern contrasts sharply with the fishing patterns in the western Pacific where significant swordfish catches are reported as far south as 40°S and minor catches as far as 50°S. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13.

183. Sosa-Nishizaki, "Spatial and temporal CPUE ..., *op. cit.*, pp. 80-85.

184. Sosa-Nishizaki and Shimizu, "Spatial and temporal CPUE trends ...," *op. cit.*, pp. 80-85.

185. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13.

186. IFOP has conducted one study and is about to publish a second. Barbieri, *op. cit.*, December 19, 1996.

187. M. A. Barbieri, M. Donoso, A. Gonzalez, V. Correa, B. Leiva, and A. Montiel, "Development and state of art of the swordfish fishery in Chile", paper delivered at the International Symposium on Pacific Swordfish, Ensenada, B.C., Mexico, December 11-14, 1994, figure 10. The above article cited one study which showed longtailed hake to be a major prey item. This may have been an anomaly given the limited number of samples. The relatively small size of this resource, suggests further investigation is needed before assessing its importance as a prey item.

188. Farrington reports that 90 percent of the contents of the swordfish stomachs he examined contained squid. Farrington, *Fishing the Pacific, op. cit.*, p. 14.

189. Barbieri, *et. al.*, "Development and state of the art ...," *op. cit.*, figure 10.

190. Chong, *op. cit.*, April 23, 1997.

191. Salas, *op. cit.*, August 26, 1997.

192. SERNAP, *Anuario Estadístico Pesquero*, p. 22. Peru does have an important squid resource, but it is highly variable and centered primarily on the northern coast. See the Peruvian chapter of this report for details.

193. University researchers recently published an interesting article on the giant squid off Chile. Francisco Fernández and Julio A. Vásquez, "Al jibia gigante *Dosidicus gigas* (Orbigny, 1835) en Chile: Análisis de una pesquería efímera," *Estud. Oceanol.*, Vol. 14, 1995, pp. 17-21. The Universidad Católica del Norte was planning a further study in 1997, but the squid could not be found to study. Julio A. Vásquez, Departamento de Biología Marina, Universidad Católica del Norte, personal communications, April 1, 1997.

194. Barbieri, *et. al.*, "Development and state of the art ...," *op. cit.*, figure 10.

195. Eleuterio Yáñez R. María Angela Barbieri B., Claudio Silva G., and Karen Nieto S., "Temperatura superficial del mar de satélites NOAA en la pesquería artesanal de pez espada (*Xiphias gladius*) de la zona central de Chile," *Revista Investigaciones Marinas*, Vol. 24, 1996 and Bar

196. Javier Chong Lay-Son, Universidad Católica de Sma. Concepción. Personal communications, December 4, 1996.

197. Rodolfo Serra, "Important life history aspects of the Chilean jack mackerel, *Trachurus symmetricus murphyi*," *Investigaciones Pesqueras*, Vol. 36, 1991, pp. 67-83.

198. Chilean jack mackerel (taken off both Chile and to a lesser extent Peru) was the third most important species taken worldwide in 1994. Only Peruvian anchovy (11.9 million t) and Alaska pollock (4.3 million t) were taken in larger quantities. (The Alaska pollock catch was only slightly larger than the Chilean jack mackerel catch. FAO, *Yearbook of Fishery Statistics*, 1994.

199. This corresponds to the long term pattern in jack mackerel seasonality. Serra, "Important life history aspects ...," *op. cit.*, pp. 69, 71.

200. A good description of the Chilean jack mackerel fishery and status of the stock is available in Maria Gabriela Böhm S, "Pesquera pelágicas: Zona central sur. Estado de situación y perspectivas del recurso," *Diagnóstico de las Principales Pesquerías Nacionales*, 1993, SGI/IFOP 94/6 (IFOP/CORFO: Santiago, 1994), pp.35-47. The authors have noted considerable disagreement among Chilean authors on jack mackerel distribution, migration, patterns, and other basic data. A much needed effort to synthesize the growing body of data is available in Serra, "Important life history aspects ...," *op. cit.*

201. Serra, "Important life history aspects ...," *op. cit.*, p. 73.

202. Jack mackerel have been reported as albacore prey items at southerly latitudes (34-41°S) of the central Pacific. Kevin Bailey, "Description and surface distribution of juvenile Peruvian jack mackerel *Trachurus murphyi* Nichols from the Subtropical Convergence Zone of the central South Pacific, *Fisheries Bulletin*, Vol. 87, No. 2, pp. 273-278. Bailey uses Peruvian jack mackerel to describe the species, but not as an indication that the fish necessarily migrated from Peruvian waters. FAO describes it as Chilean jack mackerel. No available studies are known to the authors of swordfish stomach contents at these southerly latitudes.

203. Rodolfo Serra, IFOP, personal communications, July 25, 1997.

204. Chong, *op. cit.*, December 17, 1996. One Chilean researcher who indicates that the marked seasonality of the fishery suggest migrations comprising a large portion of the south Pacific. Alfredo Torres Gutiérrez, "migraciones de *Trachurus murphyi* en el norte de Chile," *Investigación Pesquera*, Vol. 33, 1986, PP. 99-103. A good review of the jack mackerel fishery is available in Cristian Pinto G., "La eficiencia económica de la pesquería de jurel de la VIII Region: Resultados iniciales," *Boletín Informativo SIM*, No. 20, August, 1982, pp. 23-28.

205. Serra, "Important life history aspects ...," *op. cit.*, p. 80.

206. Salas, *op. cit*, August 26, 1997.

207. Chong, *op. cit.*, April 23, 1997.

208. Marron, *Albacora*, *op. cit.*, photograph opposite p. 185 and Farrington, *Fishing the Pacific, op. cit.*, p. 14 and photographs between pp. 14-17.

209. Farrington, *Fishing the Pacific, op. cit.*, p. 15.

210. Salas, *op. cit.*, August 26, 1997.

211. Francisco Ponce, Sub-Secretaría de Pesca, personal communications, December 17, 1996.

212. Barbieri, *op. cit.*, December 19, 1996.

213. Chong, *op. cit.*, December 4, 1996.

214. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 28.

215. Preliminary results from NMFS research in the north Pacific show that the composition of prey species off Hawaii appears to change seasonally (more squid during winter and spring months). Researchers caution, however, that as the grounds shift seasonally, the dietary changes could be artifacts of temporal and spatial variability of the sample collections. Michael Seki, NMFS Honolulu Laboratory, personal communications, August 25, 1997.

216 Salas, *op. cit.*, September 1, 1997.

217. Freddy Arocha, Universidad de Oriente, personal communications, August 25, 1997.

218. Yáñez, *et. al.*, "Temperatura superficial ...," *op. cit.*

219. Chong, *op. cit.*, December 17, 1996.

220. Salas, *op. cit.*, August 26, 1997.

221. Chong, *op. cit.*, December 17, 1996.

222. Ponce, *op. cit.*, December 17, 1996.

223. One sport fisherman reports that it is very difficult to get strikes in the murky water and thus the fishermen had to move into the clearer water. Farrington, *Fishing the Pacific*, *op. cit.*, p. 8.

224. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 207. The authors, however, have noted only one study for 1 year. It is not known how representative this study was. IFOP may have additional studies for other years.

225. Farrington, *Fishing the Pacific*, *op. cit.*, p. 27.

226. Miguel Donoso P. and Javier Chong L-S, "Elaboración clave talla-edad de la albacora (*Xiphias gladius* L.) durante la temporada de pesca, 1994-1995," *IFOP* no series title (IFOP: Valparaíso, November, 1995), pp. 6-7 and 14.

227. Donoso and Chong L-S, "Elaboración clave talla-edad ..., 1994-1995," *op. cit.*, pp. 6, 10-11, and 13.

228. M. Donoso and J. Chong, "Investigación clave edad-talla de desembarque de pez espada (*Xiphias gladius* L) durante la temporada de pesca 1995-1996," (IFOP: Valparaíso, 1996).

229. Barbieri, *op. cit.*, April 12, 1996; Donoso, *op. cit.*, April 12, 1996; Chong, *op. cit.*, December 4, 1996.

230. The SSP confirms that sizes declined during 1991-94, but reports that some indicators suggest that sizes increased somewhat during 1995. Officials can not explain the 1995 increase. Ponce, *op. cit.*, January 8, 1997.

231. Yabe, *et. al.*, 1959 as cited in Nakamura, *op. cit.*, p. 50. Aging swordfish continues to be a problematic exercise. Most studies of sexual maturity have focused on size which can be readily measured (Latin America, appendix B3).

232. Another Chilean study (appendices B6a) reports sizes that suggest somewhat earlier maturations (appendix B6a).

233. Chong, *et.al*, "Proyecto: Estudio del proceso ...," *op. cit.*

234. The size/age correlations in appendix B5b4 give somewhat different age correlations, but suggest a similar trend as B6b.

235. José Miguel Donoso and Javier Chong Lay-Son, "Determinación de edad y estimación de crecimiento en albacora (*Xiphias gladius*, L). Etapa I. Determinar la factibilidad de utilizar el método de lectura de marcas, bandas o annuli que se forman en estructuras duras, para determinar edad," *IFOP* (no series title) (IFOP: Valparaíso, 1992), pp. 9, 24, and 27.

236. Barbieri, *op. cit.*, January 29, 1997.

237. Yáñez and García, "La pesquería ...," *op. cit.*

238. In practice it may not be quite as selective as many of the small-scale fishermen involved may decide to take even a small swordfish.

239. While the larger size of the females within year classes is difficult to see from the attached summary (appendix B5b4), it is clear from the more detailed statistical appendices (tables 2 and 3) in the source. Donoso and Chong, "Elaboración clave ..., 1994-1995," *op. cit.*, pp 10-11.

240. While the data collected in 1994-95 suggests that gear selectivity may be the key factor, Chilean researchers are dubious about reaching such conclusions. Several alternative conclusions are possible. The limited period covered may have given aberrant results. In addition, the large oceanic areas (Zones 1, 3, and 5) do not discriminate between the differing areas in which artisanal and commercial fishermen operated. As a result, one prominent researcher believes that the area fished rather than gear selectivity is the key factor. Barbieri, *op. cit.*, December 19, 1996.

241. Donoso and Chong L-S, "Elaboración clave talla-edad ..., 1994-1995," *op. cit.*, pp. 6 and 10-11.

242. Barbieri, *op. cit.*, December 18, 1996 and Chong, *op. cit.*, December 17, 1996.

243. Chong, *op. cit.*, December 17, 1996.

244. Leiva, 1993 as cited in M. A. Barbieri, M. Donoso, A. Gonzalez, V. Correa, B. Leiva, and A. Montiel, "Development and state of art of the swordfish fishery in Chile", paper delivered at the International Symposium on Pacific Swordfish, Ensenada, B.C., Mexico, December 11-14, 1994, p. 9. Barbieri confirms this pattern in her work. Barbieri, *op. cit.*, December 19, 1996.

245. Chong, *op. cit.*, December 17, 1996 and Barbieri, *op. cit.*, January 3, 1997.

246. Gastón Clavería, SERNAP Provincial Director, San Antonio, personal communications, April 12, 1996. SERNAP currently limits the size of the net, but not the mesh size. (See "Government Agencies and Policy.")

247. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 208.

248. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 20.

249. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 20.

250. One possible complication, however, is that the oceanic zones (Zones 1, 3 and 5) developed by IFOP are quite large (map 3). It is possible that within these large areas, such as Zone 3, the driftnets and longlines were deployed in different sectors.

251. Chong, *op. cit.*, December 17, 1996.

252. Not only does the 1994-95 IFOP study cover a relatively short period, but the large oceanic areas, such as Zone 3, are not broken down by subareas. As the artisanal and commercial fishermen reportedly operated in different zones of Zone 3, the sharply different sizes may be due to the different grounds even though they both operated within Zone 3. Barbieri, *op. cit.*, December 19, 1996

253. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 208, 210.

254. IFOP, División Evaluación de Pesquerías. "Descripción de la pesquería de pez espada en la temporada 1995," *Documento Preparado para la Reunion Anual Entre SUBPESCA/SERNAPESCA/IFOP y NMFS, 1996.*

255. Some Chilean researchers believe that the grounds are the principal factor. Chong, *op. cit*, December 17, 1996 and Barbieri, *op. cit.*, December 19, 1996.

256. The limited artisanal operations in the northern offshore zone (Zone 1) make comparisons with driftnets difficult. The fact that few artisanal fishermen are operating in Zone 1 may to some degree reflect the fact that much of the available swordfish are less valuable small fish. On the other hand, the limited artisanal effort could also reflect the greater distances from their home ports, mostly along the central and southcentral coast. (See "Ports.")

257. Swordfish spawn in the warmer water, but to the west of the Chilean coast. (See "Spawning.") One possibility is that the juveniles may remain in the warmer water where the females spawn. IFOP researchers stress, however, that their preliminary findings indicate that there is no sign in the gonadal studies of mature eggs (appendix B7). Barbieri, *op. cit.*, January 3, 1997.

258. Barbieri, *op. cit.*, December 19, 1996 and Chong, *op. cit.*, December 4, 1996.

259. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 209 and Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, p. 30. The difference may be due to varying landings by driftnet and longline fishermen. The Caldera landings, for example, were limited. Detailed monthly data is also available in Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, p. 31-33.

260. IFOP, "Descripción de la pesquería ...," *op. cit.*, p. 8 and Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 30.

261. H. Schmidt, *op. cit.*, April 8, 1996.

262. H. Schmidt, *op. cit.*, April 8, 1996. The catch data available for Zone 1 (appendix B5c3) is not statistically valid because of the small sample.

263. Japan Marine Fisheries Resource Research Center (JAMARC), "Report on 1979 tuna longline fishing investigation in higher latitudes of the eastern south Pacific," *JAMARC*, No. 23, 147p. as cited in Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 208. This would mean about 60 kg fish/48 kg trunks (appendix B6b and c).

264. The values, however, appear to vary greatly from year to year.

265. Chong, *op. cit.*, December 4, 1996.

266. Most available data is compiled by gear and by port where the fish is landed. Gear data in actuality may reflect trends in the coastal and offshore fisheries. Most, but not all, of the driftnet catch is coastal. All of the commercial longline catch is taken offshore. The available landings data by port, however, can be misleading. Just because fish are landed at ports along the southcentral, central, and northern coast, does not mean that they were necessarily taken in corresponding coastal and ocean areas close to those ports. Much of the catch, especially the catch of the smaller artisanal vessels, probably is landed at nearby ports, but substantial quantities also appear to be transported considerable distances.

267. Barbieri, *op. cit.*, December 19, 1996 and Chong, *op. cit.*, December 4, 1996.

268. Barbieri, *op. cit.*, December 19, 1996.

269. The study did report substantial variations within months from the average pattern for the 1994-95 period studied (appendix B5c3).

270. The commercial fishermen reported taking very small fish in the northern offshore ground (Zone 1) averaging only 33 kg (trunk weight) (appendix B5c3).

271. George Reiger, *Profiles in Saltwater Angling* (Englewood Cliffs: Prentice Hall, 1973), p. 154. Interestingly, this record was set after the 1946 peak of the artisanal harpoon fishery. The artisanal fishermen reported a then record of 2,150 in 1946. By 1953 the catch had declined significantly to only 570 t, or by over 70 percent (appendix E2a1).

272. Farrington, *Fishing the Pacific*, *op. cit.*, p. 44.

273. Farrington, *Fishing the Pacific*, *op. cit.*, p. 43.

274. Yáñez and García, "La pesquería ...," *op. cit.*; José Donoso P. and Carlos Montenegro S., "Investigación monitoreo pesquería de albacora temporada 1992," no series title, IFOP, June, 1993, p. 22; Clavería, *op. cit.*, April 12, 1996; Barbieri, *op. cit.*, April 11, 1996; Ponce, *op. cit.*, January 8, 1997.

275. Clavería, *op. cit.*, April 12, 1996.

276. Heriberto Muñoz Concha, processing plant owner, personal communications, November 20, 1996; H.L. Schmidt, *op. cit.*, April 8, 1996; and Wadsworth, *op. cit.*, April 16, 1996.

277. Peter Wadsworth, Owner/Manager, Pesquera Catalina, personal communications, November 12, 1996.

278. José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesquería de albacora temporada 1992," (IFOP N° inven: 930009), June, 1993, figures 14-26 and IFOP, "Estado de situación y perspectivas del recurso," *Pesquerías Nacionales Demersales* (PECES), Zona Centro Sur, 1993, (Santiago: IFOP, April, 1994), figures 64-66.

279. Barbieri, *op. cit.*, January 29, 1997.

280. The ICCAT management regime in the Atlantic, for example, prohibits landing juvenile swordfish weighing less than 25 kg (live weight) or 125 cm lower jaw fork length, but permits a 15 percent tolerance as a by-catch. Smaller fish can be retained (fish as small as 119 cm) if the by-catch tolerance is eliminated. ICCAT, "Recommendation by ICCAT regarding the implementation of an alternative option for the conservation of undersized Atlantic swordfish and the reduction of fishing mortality," Annex 4-10 in *ICCAT Report*, Par II (1995), Vol. 1 (Madrid: ICCAT, 1996), p.88.

281. The limitations of the data are briefly discussed in Barbieri, *et. al.* "Development and state of art ...", *op. cit.*, pp. 6-7.

282. A "braza" is 1 fathoms or 6 feet (1.83 meters).

283. Eleuterio Yáñez R., "Estado de situación de la pesquería del pez espada en Chile," *Boletín Apropech*, No. 16, January-March, 1997, in press.

284. The authors have noted several reports on effort in the artisanal fishery. The numbers cited vary substantially (appendices C2a1-3). All three assessments show declining effort since 1991, but at different rates.

285. The catch data is not necessarily an accurate measure of effort. In a fishery like swordfish which was recently developed and now overexploited the relationship between catch and effort has changed. In the initial phase the catch increased as effort increased. As the fishery peaked in 1991 this relationship changed. Increasing effort could result in little increasing catch or even a declining catch. In addition, a withdrawal of effort may not result in proportional catch declines or even any decline at all.

286 Official SERNAP statistics over state the importance of San Antonio because the catch beyond 200-miles is not reported by port. Substantial quantities of the catch beyond 200 miles are landed at Coquimbo. As most of the catch in 1996 was taken beyond 200 miles, the available SERNAP 1996 port data does not provide a realistic picture of the activity at the various ports, especially Coquimbo.

287. IFOP reports Lebu as an important swordfish port (C2b, C21-2, F1, and F2a-b). SERNAP reports, however, that swordfish is rarely landed at Lebu (appendix F4).

288. For more details see "Species: Seasonality."

289. IFOP, "Estado de situación ..." *op. cit*, p. 59.

290. The authors are unable to explain the differences in the various studies (appendices C2a1-3).

291. González, 1993 as cited in Barbieri, *et. al.* "Development and state of art ...", *op. cit.*, p. 7.

292. Donoso and Montenegro, "Investigación monitoreo," *op. cit.*, p. 18.

293. The 1995 catch in Coquimbo was unusually high. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 46.

294. The high yield reported in the northern offshore area (Zone 1) was probably a statistical anomaly given the small sample size.

295. See "Species: Seasonality" for more details.

296. Nakano, "Stock status of swordfish ...," *op. cit.*, fig. 8.

297. Donoso and Serra, "La pesquería ...," *op. cit.*, pp. 3-4.

298. For details see the Ecuadorean chapter of this report.

299. Ponce, *op. cit.*, January 8, 1997.

300. Donoso and Serra, "La pesquería ...," *op. cit.*, p. 5.

301. IFOP, "Estado de situación ..." *op. cit*, p. 59 and Clavería, *op. cit.*, April 12, 1996.

302. Yáñez, *et. al.*, "Temperatura superficial ...," *op. cit.* and Donoso and Serra, "La pesquería ...," *op. cit.*, p. 4.

303. Donoso and Serra, "La pesquería ...," '*op. cit.*, pp. 4-5

304. Donoso and Serra, "La pesquería ...," *op. cit.*, p. 5.

305. IFOP, "Estado de situación y perspectivas del recurso," *Pesquerías Nacionales Demersales* (PECES), Zona Centro Sur, 1993, (Santiago: IFOP, April, 1994), figures 64-66.

306. Barbieri, *op. cit.*, January 29, 1997.

307. Foreign effort in other Pacific regions could also be impacting Chile, but such assessments are extremely tenuous without a more detailed understanding of the stock structure of Pacific swordfish.

308. Chilean Navy, surveillance summaries, unpublished data, July 18, 1997.

309. For details on Honduran flag-of-convenience registries see Weidner and Hall, "Latin America," *op. cit.*

310. For an overview of Japanese swordfish operations in the wider Pacific see Wildman, "Japan," *World Swordfish Fishery*, Vol. III, *op. cit.*

311. Yuji Uozumi, Distant Water Fishery Research Laboratory, personal communications, January 28, 1997.

312. Tomohiro Asakawa, U.S. Foreign Commercial Service, U.S. Embassy, Tokyo, personal communications, January 29, 1997.

313. Asakawa, *op. cit.*, January 29, 1997.

314. Uozumi, *op. cit.*, February 28, 1997.

315. Hideki Nakano, Distant Water Fishery Research Laboratory, presentation at the First International Symposium on Pacific Swordfish, Ensenada, Mexico, December 11-14, 1994.

316. Chilean Navy, surveillance reports, unpublished data, July 18, 1997. If large numbers of Japanese vessels were active in the southeastern Pacific, one would assume there would be occasional port calls in Chile.

317. The Spanish swordfish operations are conducted from Peruvian ports. For details see the Peruvian chapter of this report.

318. Chilean Navy, surveillance summaries, unpublished data, July 18, 1997.

319. For details see the Peruvian chapter of this report.

320. Ponce, *op. cit.*, January 8, 1997.

321. González, 1993 as cited in Barbieri, *et. al.* "Development and state of art ...", *op. cit.*, p. 7.

322. Parrish, "Environmental variations ...," *op. cit.*

323. Yáñez and García, "La pesquería ...," *op. cit.* and González, Barbieri, and Yáñez, "Distribución espacio-temporal ...," *op. cit.* Recreational fishermen during the 1950s reported that swordfish fishing in Peru was adversely affected as a result of a 1953 El Niño event. Farrington, *Fishing the Pacific*, *op. cit.*, p. 61.

324. Kousky, *op. cit.*, December 17, 1996.

325. Barbieri, *op. cit.*, December 19, 1996 and Quezada, *op. cit.*, January 22, 1997.

326. Kousky, *op. cit.*, December 17, 1996.

327. Parrish, "Trip report ...," *op. cit.*

328. Serra, "Important life history aspects ...," *op. cit.*, p. 78.

329. Raúl Quezada Rodríguez, Technical Consultant/Founding Member, Asociación Gremial de Pescadores de Valparaíso, personal communications, January 22, 1997.

330. Dr. Patricio Bernal, Subsecretario de Pesca, comments at United States-Chile Fishery Cooperation Talks, La Jolla California, March 20, 1995.

SECTION III (FISHING GROUNDS)

331. Farrington, *Fishing the Pacific, op. cit.*, p. 6.

332. For a good description of the Humboldt Current off Chile and associated counter current see Hellmuth A. Sievers and Nelson Silva S., "Masas de agua y circulación geostráfica frente la costa de Chile entre latitudas 18°S y 33°S," *Ciencia y Tecnolgía del Mar*, N°6, 1982, pp. 61-99.

333. A more detailed discussion of the Humboldt Current is available in Matthias Tomczak and J. Stuart Godfrey, *Regional Oceanography: An Introduction* (Pergamon: London, 1994), p. 144.

334. A good review of current flows off Chile is available in F. R. Espinoza, S. Neshyba, and Z. Mexicano, "Surface water motion off Chile has revealed in satellite images of surface chlorophyll and temperature," *Proceedings of the International Conference on Marine Resources in the Pacific,* Universidad Católica de Valparaíso, 1983, pp. 41-57.

335. The depth varies seasonally and annually. Precise depths are not available, but the force of the current appears to be less powerful than at the surface and at 150 meters, although upwelling may also affect coastal temperatures. At 400 m, for example, there appears to be virtually no difference in water temperatures between oceanic water and the water under the Humboldt Current. Levitus and Boyer, "Temperature," *op. cit.*, pp. 44-52.

336. Nelson Silva S., "Masas de agua y circulación en la region norte de Chile," *Ciencia y Tecnolgía del Mar*, N°7, 1983, pp. 47-84.

337. Sievers and Silva S. "Masas de agua ...," *op. cit.*

338. Uribe and Salazar, "Swordfish (*Xiphias gladius*) catch distributions ...," *op. cit*, pp. 851-857.

339. See for example the different descriptions presented in Colombia figure 10 and Chile figure 17.

340. A good description of upwelling off Chile is available in T.R. Fonseca and M. Farias, "Estudio del proceso de surgencia en la costa chilena utilizando percepción remota," *Investigación Pesquera*, Vol. 34, 1982, pp. 22-46.

341. Sidney Shapiro, *The Fisheries of Chile* (Bureau of Commercial Fisheries: Washington, D.C., 1965), pp. 2-3.

342. A more detailed discussion of the Chile/Peru upwelling system is available in Tomczak and Godfrey, *Regional Oceanography*, *op. cit.*, pp. 144-145. A good assessment of upwelling off central Chile is available in Donald R. Johnson, Thomas Fonseca, and Helmuth Sievers, "Upwelling in the Humboldt coastal current near Valparaíso, Chile," *Journal of Marine Research*, February, 1980, pp. 1-16.

343. Reiger, *Profiles in Saltwater Angling*, *op. cit.*, p. 154.

344. Swordfish migratory movement in the southeastern Pacific are largely unknown. A circular swordfish migratory path including a movement to southern latitudes at mid-ocean longitudes of the eastern Pacific is one possibility. Some foreign catch data suggests such a path, although data at southern latitudes is limited, and not adequate to form any substantial theories. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13. For details see "Species: Migrations". Chilean coastal catch patterns indicating a northern shift of the fishery with the northern flow of the Humboldt Current as the season progresses fits into this overall pattern.

345. Chong, *op. cit.*, December 4, 1996.

346. Alexis Silva Martínez, Pesquera del Estrecho, personal communications, December 12, 1996 and Yáñez, *et. al.*, "Temperatura superficial ...," *op. cit.*

347. D.P. De Sylva, "Red-water blooms off northern Chile, April-May 1956, with reference to the ecology of the swordfish and striped marlin," *Pacific Science*, 1962, Vol. XVI, No. 3, pp. 271-279.

348. FAO, *Yearbook of Fishery Statistics*, 1978.

349. Parish, "Environmental variations ...," *op. cit.*

350. Gonzalez, *et. al.*, "Distribución espacio ...," *op. cit.*

351. The fishery was probably active before the 1930s, but the authors have no information on this earlier period.

352. Barbieri, *et.al.*, "Development and state of art ...", *op. cit.*

353. Farrington, *Fishing the Pacific*, *op. cit.*, p. 6.

354. The Spanish, however, have operations extending further south than the Chilean fleet Ramon Salas, Chilean vessel captain working with SIPESCA (Peruvian company), personal communications, August 26, 1997.

355. Swordfish are not necessarily caught off the region where they are landed. One observer, for example, reports that fish caught off Regions VII and VIII are often landed at San Antonio (Region V). Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, p. 30. This is partly because San Antonio is located relatively close to the Santiago international airport, greatly facilitating the handling of fresh product.

356. The bulk of the fishing is reported from 33-35°S and 130-100-160 km offshore. Donoso and Serra, "La pesquería ...," *op. cit.*, p. 1 and Barbieri, *et.al.*, "Development and state of art ...," *op. cit.*.

357. Donoso and Serra, "La pesquería ...," *op. cit.*, p. 2 and Salas, *op. cit.*, September 1, 1997. The presence of swordfish around the Juan Fernández Islands may be related to the availability of prey. Jack mackerel, for example, appear to be abundant off the islands. J. Sateler as cited in Serra, "Important life history aspects ...," *op. cit.*, p.81.

358. P. Yáñez, "Peces útiles de la costa chilena," *Rev. Biol. Mar.*, 1955, Vol. VI, No. 1-3, pp. 29-81.

359. Salas, *op. cit.*, August 26, 1997. Presumably the fishing off Peru was outside the 200-mile zone.

360. Donoso and Serra, "La pesquería ...," *op. cit.*, p. 2.

361. Donoso and Serra, "La pesquería ...," *op. cit.*, pp. 1-2 and Salas, *op. cit.*, September 1, 1997.

362. Miguel Donoso, IFOP, personal communications, April 11, 1996.

363. Donoso and Serra, "La pesquería ...," *op. cit.*, p. 1.

364. Barbieri, *et.al.*, "Development and state of art ...," *op. cit.*, p. 7. and Yáñez, *et. al.*, "Temperatura superficial ...," *op. cit.*

365. Rolando Carrasco, General Manager, Pesquera del Estrecho. Personal communications, November 6, 1996.

366. Donoso and Serra, "La pesquería ...," *op. cit.*, pp. 1-2.

367. Quezada, *op. cit.*, January 22, 1997. The authors do not have data confirming this shift, but it certainly is plausible that oceanographic events or long-term cycles could affect swordfish distribution.

368. Quezada, *op. cit.*, January 22, 1997.

369. Swordfish are capable of long migrations and such migrations have been documented through tagging studies, although not off Chile. The tagging studies, however, have also found seemingly resident individuals, at least for certain periods. (See: "Species: Migrations".)

370. Donoso, *op. cit.*, April 11, 1996.

371. IFOP data collected during 1994-95 shows little difference between artisanal catch rates in operations off the inshore (Zone 4) and offshore (Zone 3) areas of the central coast. The limited period covered, however, preclude drawing any firm conclusions (appendices C2d and e).

372. SERNAP data is based upon landings data, but is expressed as live weight and thus is an approximation of the catch. As a result, the authors in the statistical appendices (appendix E2e1) refer to the data as "catch."

373. The commercial fishermen also use San Antonio extensively, although the proportion of their landings, taken within 200 miles, is less (30-54 percent) than that of the artisanal fleet (appendix E4d2). This does not, however, reflect swordfish distribution in coastal waters as the commercial fishermen are restricted to offshore grounds.

374. Some relatively high yields are noted in areas which are not heavily fished, but given the limited data, these high yields are probably not meaningful.

375. Full year data would probably show these two areas are of even greater importance.

376. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, pp. 15-19.

377. Eduardo Uribe and Claudio Salazar, "Swordfish (*Xiphias gladius*) catch distributions relative to environmental features observed from satellites off Coquimbo-Chile (30°S," *Conference for Pacific Ocean Environments & Probing (PORSEC'92 Proceedings*, Vol. 2, Okinawa Japan, August 25-31, 1992, pp. 851-857.

378. Carrasco, *op. cit.*, November 6, 1996.

379. Chilean fishermen appear to have done at least some test fishing north of 18°S. One fisherman described taking very small fish, making operations unprofitable. H. Schmidt, *op. cit.*, April 8, 1996.

380. Guillermo Bornscheuer, Director de Estadísticas, SERNAP, personal communications, October 4, 1997.

381. Eduardo Viveros Opazo, Director de Fiscalización, Region IV, SERNAP, personal communications, April 7, 1996. The commercial longliners also use San Antonio which is nearer to the Santiago airport than Coquimbo, but is further from the fishing grounds. San Antonio is also a much busier port than Coquimbo.

382. Existing regulations only require the fishermen to report landings by port for the fish taken within the 200-mile EEZ, because until recently there was no fishing outside the EEZ. SERNAP is now assessing possible changes in the reporting regulations. Bornscheuer, *op. cit.*, October 4, 1997.

383. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 16.

384. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13; Uozumi and Yokawa, "Country report ...," *op. cit.*, p. 6; and Sosa-Nishizaki and Shimizu, "Spatial and temporal CPUE trends ...," *op. cit.*, pp. 80-85.

385. For details on this fishery see the Colombian and Ecuadorean chapters.

386. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 13. The source includes other Asian longline data, but most of the eastern Pacific swordfish appears to be landed by the Japanese. Another geographical assessment of Japanese swordfish data during the 1990s is available in Uozumi and Yokawa, "Country report ...," *op. cit.*, p. 6.

387. The authors stress, however, that the primary target species was bigeye, which may explains the scattered swordfish results at southern latitudes off Chile. Sosa-Nishizaki and Shimizu, "Spatial and temporal CPUE trends ...," *op. cit.*, pp. 80-85. See also Nakano, "Stock status of swordfish ...," fig. 2.

388. The longitudes cited above refer to the area off northern Chile, all at 20-25°S. National Fisheries Research and Development Agency (NFRDA) (Korea), "Fishery statistics and fishing grounds for the Korean tuna longline fishery, 1988-1992" *Technical Report of the NFRDA*, (NFRDA: Seoul, December 1993), 465p.

389. Echandía Zegarra, *op. cit.*, June 21, 1996; Salas, *op. cit.*, August 26 and September 1, 1997; and Schmidt, *op. cit.*, April 8, 1996.

390. Donoso and Serra, "La pesquería ...," *op. cit.*, p. 2.

391. Salas, *op. cit.*, September 1, 1997.

392. Tuna Research Center (TRC), *Annual Catch Statistics of Taiwanese Tuna Longline Fishery* (Institute of Oceanography: Taipei, December 1993), (F1-25).

393. See "International" for available details.

394. Covarrubias, *op. cit.*, April 12, 1996. For details see the Uruguayan chapter of this report.

395. One of the longliners, *Isla Guafo*, targeting toothfish was gutted by fire about 50 km off Port Stanley on the Falkland Islands in 1996. The crew included two Spanish and an Australian citizen.

396. Kirt Blinsinger, personal communications, August 28, 1995.

397. Covarrubias, *op. cit.*, September 17, 1997.

398. Enrique Pereira, Pesquerías Belnova, personal communications, April 15, 1996.

SECTION IV. **(Fleet)**

399. The authors stress that this is not a criticism of SERNAP who went to considerable effort to tabulate the vessel data from their landings reports. The authors are simply relating SERNAP's own evaluation of the data.

compiled for this report.

400. Guillermo Bornscheuer, Director de Estadísticas, SERNAP, personal communications, October 1, 1997.

401. One observer reported a slightly larger number of vessels, 517 in 1991 (appendix A2e).

402. Covarrubias, *op. cit.*, August 18, 1995. Ley 19.080, Art. 1°, Letra G.

403. SERNAP reports that 16 longliners were based in Region VII (Constitución) during 1996 (appendix A3d). Some of these longliners targeting swordfish.

404. González, 1993 as cited in Barbieri, *et. al.*, "Development and state of art ...", *op. cit.*, p. 3.

405. Barbieri, *et. al.* "Development and state of art ...", *op. cit.*, p. 3.

406. Donoso, *op. cit.*, September 10, 1997. See "Catch" for a fuller discussion of factors affecting the 1996 decline in the artisanal catch.

407. Guillermo Bornscheuer, Director se Estadísticas, SERNAP, personal communications, October 3, 1997.

408. IFOP, "Diagnostico de las principales pesquerías nacionales demersales (peces), zona central sur-1993," *Estado de Situación y Perspectivas del Recurso* (IFOP: Valparaíso, April, 1994), p. 54.

409. Barbieri, *op. cit.*, January 29, 1997.

410. Several species of groundfish are targeted, two of the most important are "bacalao de profundidad" or "mero" (Patagonian toothfish, *Dissostichus eleginoides*) and "merluza del sur" (southern hake, *Merluccius australis*).

411. Clavería, *op. cit.*, April 12, 1996.

412. Silva Martínez, *op. cit.*, December 12, 1996.

413. Carrasco, *op. cit.*, November 6, 1996.

414. See "Government Agencies and Policy" for the official definition of artisanal fishing.

415. Barbieri, *et. al.* "Development and state of art ...", *op. cit.*, p. 3.

416. The authors have received varying vessel estimates (appendices A2b1 and A4a). The discrepancies may refer to differences in the size of the vessels included or whether the vessel is active or not.

417. Covarrubias, *op. cit.*, August 17, 1995. Some authors mention artisanal vessels up to 20 meters. Barbieri, *et. al.* "Development and state of art ...", *op. cit.*, p. 3.

418. Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, pp. 27-28.

419. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 206.

420. Farrington, *Fishing the Pacific*, *op. cit.*, p. 50 and Marron, *Albacora*, *op. cit.*, pp. 155-156.

421. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 206.

422. Marron, *Albacora*, *op. cit.*, p. 156.

423. Barbieri, "Development and state of art ...," *op. cit.*, fig. 3. One company purchasing from the artisanal fishermen estimated about 300 lanchas in 1996. Wadsworth, *op. cit.*, November 12, 1996.

424. SERNAP provides sharply different data on vessels (appendix A2b1). The authors are unable to resolve the discrepancies between the two data sets.

425. Donoso, *op. cit.*, September 10, 1997.

426. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. iv.

427. Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, pp. 27-28.

428. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 206.

429. Chilean fishermen use the Spanish-language term "industrial" when describing commercial fisheries and vessels. The authors have used commercial because in English, "industrial" sometimes refers to small pelagic fisheries to supply fishmeal reduction plant. The Spanish term "comercial", however, can not be used as it is widely used for marketing, but not to describe types of fisheries and vessels.

430. IFOP, "Estado de situación y perspectivas del recurso," *Pesquerías Nacionales Demersales* (PECES), Zona Centro Sur, 1993, (Santiago: IFOP, April, 1994), p. 45.

431. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, pp. iv-v.

432. Pesquera Marazul reports, for example, that its four longliners during 1996 were deploying bottom longlines for Patagonian toothfish during 1996. Anonymous Pesquera Marazul official, personal communications, November 19, 1996.

433. If a company owns more than one vessels, the vessels (no matter how small) are considered part of the commercial fleet.

434. Ponce, *op. cit.*, January 8, 1997.

435. Departamento de Fiscalización, "Infrastructura ...," *op. cit.*

436. See "Gear and Fleet Operations."

437. Richard Schaefer, Chief, Staff Office of Inter-Governmental and Recreational Fisheries, NMFS, personal communications, December 20, 1996 and SERNAP, Departamento de Fiscalización, "Infrastructura ...," *op. cit.*

438. Rusque, *op. cit.*, April 2, 1996.

SECTION V. (Shipyards)

439. Clavería, *op. cit.*, April 12, 1996.

440. "Chile orders keep Marco busy," *Fishing News International*, November 1988, p. 62.

441. For details see Weidner and Hall, "Latin America," *op. cit.*, pp. 310-312; "The largest fishing vessel built in Chile," *ASMAR News*, January-July, 1994; and "ASMAR: Capacidad y alta tecnología en la construcción naval," *Chile Pesquero*, June-July, 1994, pp. 39-41.

442. "Seiner deck gear package signed up," *Fishing News International*, January, 1997.

443. "Designs on big ships," *Fishing News International*, January, 1997 and "Biggest ship yet?" *Fishing News International*, January, 1997.

444. "Chile orders ...," *op. cit.*, p. 62.

445. Many of the major longline countries, especially Japan, are having to reduce the size of their fleets for resource or economic reasons. Japan for example is having increasing difficult recruiting crew members willing to accept the rigorous working conditions. For details see the chapters on these countries in the Asian and European volumes of this study. Wildman, *World Swordfish Fishery*, vol. III, *op. cit.* and Folsom, *World Swordfish Fishery*, vol. VI, *op. cit.*

446. Marco promotional literature, 1994.

447. Barbieri, *et. al.*, "Development and state of art ...," *op. cit.*, p. 4.

448. Ricardo Cortés D., Director, EDITEC, *Catálogo Técnico de Buques Pesqueros y Remolcadores de Alta Mar* (EDITEC: Santiago, 1994), pp.156-167.

449. Eleuterio Yáñez, Universidad Católica de Valparaíso, personal communications, January 22, 1997.

450. Ponce, *op. cit.*, January 16, 1997.

451. See add, "Why has our good name passed frontiers?," *World Fishing*, November, 1994, p. 14.

452. ASMAR like ASENAV advertises regularly in foreign fishery journals. See for example "The shipbuilding capability of ASMAR, *Fishing News International* (Chile Supplement), February 1991, p. 27.

453. *ASMAR News*, October-December, 1993. Several of these countries (Cyprus, Liberia, and Panama) make flag-of-convenience registrations.

454. The vessels involved were fishing vessels (a squid jigger and a fish factory ship), an ocean-going tug, two supply vessels, a LPG carrier, a support ship, a barge, and a ferry. "SAEM yard providing to be in ideal position," *World Fishing*, February, 1988, p. 45.

455. These distant-water fisheries are described in Weidner and Hall, "Latin America," *op. cit.*

456. Alejandro Sandino Corbet, Administrator, Astilleros y Maestranzas de la Armada (ASMAR), personal communications, December 5, 1995. In addition, the Argentine and Brazilian policies have further discouraged foreign fishing.

457. Chile allows foreign fishermen to tranship a variety of species through Puntas Arenas and Arica, but not Pacific swordfish. Covarrubias, *op. cit.*, April 12, 1996.

SECTION VI. (Gear and Fleet Operations)

458. For simplicity sake referred to as driftnets in this report.

459. Clavería, *op. cit.*, April 12, 1996.

460. Silva Martínez, *op. cit.*, April 8, 1996.

461. Covarrubias, *op. cit.*, October 17, 1995.

462. One factor was the small boats used by the fishermen and the recoil of the rifle. Charles Olesen, "Informe al gobierno de Chile sobre la pesca con embarcaciones menores," *Informe FAO* N°907 (FAO: Rome, 1958), p. 40.

463. Barbieri, *et. al.* "Development and state of art ...", *op. cit.*, p. 5.

464. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 206. Chilean sources often express sizes in fathoms ("brazas") which are 6 feet. As the metric equivalent is somewhat awkward, the authors have used brazas in various sections of the report.

465. Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, pp. 27-28. Another observer reports a similar estimate, driftnets from 2.0-3.5 km and 55 m deep. Wadsworth, *op. cit.*, November 12, 1996.

466. Uribe and Salazar, "Swordfish (*Xiphias gladius*) catch distributions ...," *op. cit*, pp. 852.

467. Covarrubias, *op. cit.*, February 14, 1997.

468. Barbieri, *op. cit.*, April 11, 1996 and Clavería, *op. cit.*, April 12, 1996. One observer reports that the 20 inches (51 cm) mesh is the most common. Ponce, *op. cit.*, January 8, 1997.

469. Wadsworth, *op. cit.*, November 12, 1996.

470. Clavería, *op. cit.*, April 12, 1996.

471. Ponce, *op. cit.*, January 8, 1997.

472. Yáñez, *et. al.* "Development and state of art ...", *op. cit.*, p. 4.

473. Ponce, *op. cit.*, January 8, 1997.

474. Polyethylene is a colored polymer while nylon is neutral density and invisible in the water. Benny A. Rohr, NMFS Pascagoula Laboratory, personal communications, September 10, 1997.

475. Ponce, *op. cit.*, January 8, 1997.

476. Covarrubias, *op. cit.*, February 14, 1997.

477. Ponce, *op. cit.*, December 17, 1996.

478. Silva Martínez, *op. cit.*, December 12, 1996.

479. Quezada, *op. cit.*, January 22, 1997.

480. Silva Martínez, *op. cit.*, December 12, 1996.

481. Barbieri, *op. cit.*, January 3, 1997.

482. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. v.

483. Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, p. 27.

484. Donoso, *op. cit.*, April 11, 1996.

485. Quezada, *op. cit.*, January 22, 1997.

486. A detailed explanation of light sticks and their use can be found in Water Flanagan and Edward Gaw, *Long Line Fishing for Big Fish* which is to be published in 1997.

487. Covarrubias, *op. cit.*, October 17, 1995 and February 14, 1997.

488. Donoso and Montenegro, "Investigación monitoreo ... 1992," *op. cit.*, p. 16. In addition, the small open vessels traditionally used for harpooning can not be deployed in rough weather.

489. Olesen, "Informe al gobierno ...," *op. cit.*, p. 41.

490. Marron, *Albacora*, *op. cit.*, pp. 155-156 and Farrington, *Fishing in the Pacific*, *op. cit.*, pp. 7 and 50.

491. Olesen, "Informe al gobierno ...," *op. cit.*, p. 41.

492. Marron, *Albacora*, *op. cit.*, pp. 155-156 and Farrington, *Fishing in the Pacific*, *op. cit.*, pp. 7 and 50.

493. Olesen, "Informe al gobierno ...," *op. cit.*, p. 41.

494. Marron, *Albacora*, *op. cit.*, pp. 155-156 and Farrington, *Fishing in the Pacific*, *op. cit.*, pp. 7 and 50.

495. One FAO expert reports surprising fishermen and company officials during the 1950s who doubted there were swordfish off Valparaíso by harpooning two. Whalers operating off souther Chile also reported swordfish. Olesen, "Informe al gobierno ...," *op. cit.*, p. 40. The FAO report is unclear as to whether there were always swordfish off southern Chile or if the distribution was changing in the 1950s. Olesen appears to believe that abundance along the central coast was increasing during the 1950s.

496. Barbieri, *op. cit.*, January 3, 1997.

497. Ponce, *op. cit.*, January 8, 1997.

498. Donoso, *op. cit.*, April 11, 1996 and Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 206.

499. Only a few of the artisanal vessels which are mostly based in central Chilean ports are able to conduct operations as far north as Caldera and Coquimbo. Covarrubias, *op. cit.*, October 17, 1995.

500. Covarrubias, *op. cit.*, October 17, 1995.

501. Covarrubias, *op. cit.*, February 14, 1997.

502. Barbieri, *op. cit.*, January 3, 1997 and Ponce, *op. cit.*, January 8, 1997.

503. Donoso and Montenegro, "Investigación monitoreo ... 1992, *op. cit.*, p. 15.

504. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 14.

505. Barbieri, *et. al.* "Development and state of art ...", *op. cit.*, p. 5.

506. Wadsworth, *op. cit.*, November 12, 1996.

507. Clavería, *op. cit.*, April 12, 1996.

508. Ponce, *op. cit.*, January 8, 1997.

509. Ponce Martínez and Bustos, "La Pesquería ...," *op. cit,*, p. 25.

510. Barbieri, *op. cit.*, January 3, 1997.

511. Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, p. 30.

512. Donoso and Montenegro, "Investigación monitoreo," *op. cit.*, p. 16.

513. Donoso and Montenegro, "Investigación monitoreo ... 1992," *op. cit.*, p. 14.

514. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 13.

515. Barbieri, *op. cit.*, January 3, 1997.

516. Quezada, *op. cit.*, January 22, 1997.

517. Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, p. 30.

518. Clavería, *op. cit.*, April 12, 1996. Another observer reports 1-2 trips per month at the peak of the season. Barbieri, *op. cit.*, January 3, 1997.

519. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 14.

520. Barbieri, *et. al.*, "Development and state of art ...," *op. cit.*, p. 4.

521. One artisanal fisherman in Coquimbo indicated that he primarily targeted "bacalao" about 13-20 km off the coast, making 1-2 day trips. He occasionally takes a swordfish, sometimes with a harpoon. Gabriel Arraya, Captain of the *Santa Rosa*, personal communications, April 8, 1996.

522. Clavería, *op. cit.*, April 12, 1996 and Burgos, *op. cit.*, January 27, 1997.

523. Covarrubias, *op. cit.*, February 14, 1997.

524. Quezada, *op. cit.*, January 22, 1997.

525. Reyes, "Pesquería y mercado ...," *op. cit.*, pp. 30-31.

526. The study focused primarily on tuna, but there was a swordfish by-catch reported. Carlos Martínez, "Prospección de atunes y peces espadas en el Océano Pacífico oriental al este de los 110°W: Segundo semestre de 1971," (IFOP N° inven: 740002), December, 1974 and Gerson Lizama F. and Fernando Naranjo G., "Utilización del palangre en la pesca del pez espada," *Chile Pesquero*, July-August, 1989, pp. 43, 45.

527. The SERNAP data refers to the port where the vessel is registered. Actual operations are often conducted from other ports. Some of the San Antonio (Region V) longliners (appendix A3d) often landed their catch at Coquimbo to the north. Usually vessels from several different ports can be seen at San Antonio and other major ports (photo 88).

528. Yáñez, *op. cit.*, January 22, 1997.

529. The operations described are that of the *Talcan*. Rolando Carrasco, General Manager, Pesquera del Estrecho, personal communications, November 6, 1996.

530. Salas, *op. cit.*, September 21, 1997.

531. Barbieri, *op. cit.*, January 3, 1997 and Carrasco, *op. cit.*, November 6, 1996.

532. Barbieri, *et. al.* "Development and state of art ...", *op. cit.*, p. 5.

533. Anonymous, Pesquera Marazul official, personal communications, November 20, 1996.

534. One observer reported 20 days in 1994. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, pp. 13-14. The same observer as well as other industry sources have more recently noted trips of up to 25 days. Barbieri, *op. cit*, January 3, 1997 and Silva Martínez, *op. cit.*, December 12, 1996.

535. Carrasco, *op. cit.*, November 6, 1996.

536. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 14.

537. Carrasco, *op. cit.*, November 6, 1996; Ponce, *op. cit.*, January 8, 1997; Quezada, *op. cit.*, January 22, 1997.

538. For a description of one company's operations using Spanish methods see "Companies: Empresa del Estrecho."

539. Barbieri, *op. cit.*, January 3, 1997.

540. Silva Martínez, *op. cit.*, December 12, 1996 and Hans Louis Schmidt, General Manager, Pesquera Omega, personal communications, April 8, 1996.

541. Barbieri, *et. al.* "Development and state of art ...", *op. cit.*, p. 4.

542. Donoso, *op. cit.*, April 11, 1996 and Salas, *op. cit.*, September 1, 1997.

543. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 14.

544. Ponce Martínez and Bustos, "La Pesquería ...," *op. cit.*, p. 25.

545. Frozen product constituted a very large part of Chilean swordfish production from 1987-91 (40-55 percent), but subsequently declined sharply. Frozen product fell to only about 32 percent in 1994 and a mere 6 percent in 1995, but increased to 18 percent in 1996 (appendix G2a). As almost all of the frozen product is produced by the commercial fleet, the major reorientation of longline operations is apparent.

546. Alexis Silva Martinez, Pesquera del Estrecho, personal communications, December 12, 1996.

547. IFOP, "Descripción de la pesquería ...," *op. cit.*, pp. 4 and 9.

548. Two good descriptions of recreational fishing in Chile during the 1970s and 1980s are available in Servicio Agrícola y Ganadero, *Cartilla para Pescadores Deportivos*, 1977, 36p. and Servicio Nacional de Turismo (SERNATUR), *Guia de Pesca Deportiva en Chile*, 1984, 47p.

549. Richard Schaefer, "Trip Report", Chilean trip, November 17-28, 1996, December 24, 1996. A good review of the current status of the marine recreational fishery has been prepared by SERNAP. SERNAP, Departamento de Fiscalización, "Infraestructura de apoyo a la pesca deportiva marina en Chile," (SERNAP: Valparaíso, 1996), 25p.

550. Reyes, "Pesquería y mercado ...," *op. cit*, p. 29.

551. Farrington, *Fishing the Pacific*, *op. cit.*, pp. 4, 11, and 17.

552. Fascinating descriptions of sport fishing during the 1950s are available in Farrington, *Fishing in the Pacific, op. cit.* and Marron, *Albacora, op. cit.*

553. Reiger, *Profiles in Saltwater Angling*, *op. cit.*, p. 154.

554. Given the heavy commercial exploitation of swordfish in every ocean, it is not a record that is likely to be broken for the foreseeable future.

555. The records were set by famed U.S. big-game fisherman Lou Marron and his wife and another U.S. fisherman, Mrs. D.A. Allison. An informative description of the Marrons' experience is available in Marron, *Albacora*, *op.cit.*

556. The fishermen involved were George Garey, W.E.S. Tucker, Harlan Major, Mr and Mrs. S. Kip Farrington, and Michael Lerner. For an interesting description of efforts by outdoor corespondents in the 1930s to promote swordfish fishing in Chile see Reiger, *Profiles ...*, *op. cit.*, pp. 152-154.

557. The swordfish were caught by an energetic Florida recreational boat operator, Captain Rick Defeo, who helped save some Chilean artisanal fishermen who he found adrift. The fishermen despite their ordeal were anxious to return to sea to catch large swordfish they had observed. Defeo, *op. cit.*, September 25, 1997.

558. Farrington, *Fishing the Pacific*, *op. cit.*, pp. 16-27.

559. Farrington, *Fishing the Pacific*, *op. cit.*, p. 15.

560. One noted expert claims that swordfish "would rather kill than feed." As a result, swordfish strikes at the bait with its bill rather than taking it in its mouth. Hooks are more likely to snag the fins or tail, which is referred to as "foul-hooked." About 90 percent of all hooked swordfish are "foul-hooked" and thus very difficult to land. Marron, *Albacora*, *op. cit.*, pp. 43, 45-46.

561. Farrington, *Fishing the Pacific*, *op. cit.*, p. 9. The author provides detailed guidelines for the fishing strategy to be used with swordfish. Farrington, *Fishing the Pacific*, *op. cit.*, pp. 15-27.

562. Swordfish trips would have to be conducted at greater distances from the coast than is generally the case for other billfish. In addition, the species' feeding pattern suggest that the best fishery would have to be conducted at night, presumably on fairly large boats with sleeping accommodations. This is not the general pattern for big-game sports fishing where the anglers go out in small boats, enjoy a sunny day at sea, and then return to often comfortable hotel rooms. Some fishermen and their spouses may find long trips, nightfishing, and sleeping at sea less inviting. In addition, the larger vessels and longer trips mean that sport fishing for swordfish can be quite expensive. Fishermen during the 1930s-50s reported considerable success trolling with baited hooks so some day time fishing may also be possible.

563. SERNAP, "Infrastructura ...," *op. cit.*

564. SERNAP, "Infrastructura ...," *op. cit.*

565. Reyes," Pesquería y mercado ...," *op. cit.*, pp. 30-31.

566. SERNATUR, *Guia ...*, *op. cit.*, p. 29.

567. "Sport fishing emphasizes diversity of Chilean waters," *Chilean Economic Report*, December, 2987, pp. 6-7.

568. Dr. Juan Rusque, Director, SERNAP, comments at the United States-Chile Fishery Cooperation Talks, Santiago, Chile, April 2, 1996 and Clara Munita Ortiz, interview with Juan Rusque Alcaino, *Aquanoticias Internacional*, December 1992, p. 53.

569. Covarrubias, "Infrastructura ...," *op. cit.*

570. Schaefer, "Trip report," *op. cit.*

571. Wadsworth, *op. cit.*, December 8, 1995.

572. Ponce, *op. cit.*, January 8, 1997.

573. One study estimated 4,500 in 1990. IFOP, "Recurso albacora," *Estudio Biológico Pesquero*, doc. no. 900016, presumably 1990, p. 2. Other observers estimated 7,000 fishermen in 1991. Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, p. 25.

574. Barbieri, *et. al.*, 1989, 1991 as cited in Barbieri, "Development and state of art ...," *op. cit.*, p. 5.

575. Yáñez, *et. al.*, 1994 as cited in Barbieri *et. al.*, "Development and state of art ...," *op. cit.*, p. 6.

576. Jaime Arancibia, Systems Specialist, Centro de Estudios Espaciales, Universidad de Chile, personal communications, January 29, 1997.

577. Barbieri, *op. cit.*, April 12, 1996.

578. Barbieri, *op. cit.*, December 19, 1996.

579. Barbieri *et. al.*, "Development and state of art ...," *op. cit.*, pp. 5-6.

580. Barbieri, *et. al.* "Development and state of art ...", *op. cit.*, p. 2, 5.

581. Donoso, *op. cit.*, April 12, 1996.

582. See for example Yáñez, *et. al.*, "Temperatura superficial ...," *op. cit.*

583. Barbieri, *op. cit.*, December 19, 1996.

584. Barbieri, *op. cit.*, December 19, 1996.

585. Yáñez, *et. al.*, "Temperatura superficial ...," *op. cit.*

586. Silva Martínez, *op. cit.*, December 12, 1996.

587. Barbieri, *op. cit.*, December 19, 1996.

588. Silva Martínez, *op. cit.*, December 12, 1996.

SECTION VII (Catch)

589. C. Oliver, "Catálogo de los peces marinos del litoral de Concepción y Arauco," *Bol. Soc. Biol. Concepción*, Vol. XVII, 1943.

590. Barbieri, *et. al.*, "Development and state of art ...," *op. cit.*

591. This contrasts with the fishery developing in the late 1940s in Peru which produced fish for export. For details see the Peruvian chapter of this report.

592. Luis Pomar, *Historia de la Industria Pesquera en Chile* (Santiago: 1958).

593. Recaredo Amengual as cited in Reyes, " Pesquería y mercado ...," *op. cit.*, p. 30.

594. Olesen, "Informe al gobierno ...," *op. cit.*, p. 40.

595. Recaredo Amengual as cited in Reyes, " Pesquería y mercado ...," *op. cit.*, p. 30.

596. M.P. Hernández, *Informaciones Estadísticas Sobre Pesca*," Dirección de Pesca y Caza, Valparaíso, 56p. as cited in Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 204.

597. Reiger, "Profiles ...," *op. cit.*, pp. 153-154.

598. The Peruvian fishery reported catches of a reported 6,900 t in 1950. The development of the Peruvian fishery was assisted by the entry of U.S. freezer vessels which permitted exports to the United States for the first time. For details see the Peruvian chapter of this report. The authors have no details on why the Chilean fishery reported such large catches during this period.

599. Hernández, "Informaciones ...," *op. cit.*

600. Reyes, "Pesquería y mercado ...," *op. cit.*, p. 30.

601. Farrington, *Fishing the Pacific*, *op. cit.*, p. 51 and Olesen, "Informe al gobierno ...," p. 41.

602. Olesen, "Informe al gobierno ...," *op. cit.*, pp. 40-42.

603. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 204.

604. Harpooning is extremely labor intensive. It is generally difficult (but not impossible) to overfish a resource using harpoons. The overfishing of swordfish stocks worldwide during the 1990s is largely due to the deployment of more efficient gear such as driftnets and longlines.

605. A fuller assessment of the impact of the fishmeal industry on swordfish and other large pelagics is needed. The industry in Peru centered on anchovy, but Peruvian observers believe that fluctuations of anchovy and fauna that feed on anchovy would not affect swordfish. Kameya, *op. cit.*, August 14, 1997. Chilean companies also targeted sardines, the populations of which may have more impact on populations of swordfish and the species they feed upon. Chilean fishermen until the 1990s, however, did not harvest significant quantities of jack mackerel.

606. Notably, the Chilean reduction fishery for small pelagic species was initially conducted out of the northern ports of Iquique, Antofagasta, and Caldera where the harpoon fishermen were located.

607. Kameya, *op. cit.*, August 14, 1997.

608. Reiger, "Profiles ...," *op. cit.*, pp. 153-154.

609. John A. Manning, "Summary of investigations on the pelagic fish survey of Chilean waters with special reference to the swordfish, marlins, and tunas," 57-4, Marine Laboratory, University of Miami.

610. Paul Ström, "Informe al gobierno de Chile sobre la pesca costera con pequeñas embarcaciones motorizadas." *FAO Informe*, N°2039 (FAO" Rome, 1965), p. 9.

611. The authors have no information on why the harpoon fishermen began moving. It may have been because of declining swordfish catches and a desire to enter alternative fisheries or to continue fishing swordfish on more productive grounds.

612. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 204.

613. Reyes, "Pesquería y mercado ...," *op. cit.*, p. 31.

614. Reyes, "Pesquería y mercado ...," *op. cit.*, p. 32.

615. Yáñez and García, *op. cit.*

616. Peter Wadsworth, Owner/Manager, Pesquera Catalina, personal communications, December 8, 1995

617. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 206 and Reyes, "Pesquería y mercado ...," *op. cit.*, p. 31.

618. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 206.

619. Reyes, "Pesquería y mercado ...," *op. cit.*, p. 31.

620. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 1.

621. Yáñez and García, "La pesquería ...," *op. cit.*

622. Carlos Martínez, "Principales tendencias tecnológicas de la embarcación pesquera artesanal," in M.A. Barbieri, ed. *Perspectivas de la Actividad Pesquera en Chile* (Escuela Ciencias del Mar, UCV: Valparaíso, 1989).

623. Miguel Donoso, IFOP, personal communications, April 11, 1996. Another observer estimates that the use of drift nets increased from 20 vessels in 1986 to about 400 vessels only 2 years later in 1988. The source speculated that by 1990 virtually the entire artisanal fleet targeting swordfish was equipped with driftnets. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 206. Many of the fishermen installed a "tangón" for opportunistic harpoon fishing.

624. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 206.

625. Ponce, *op. cit.*, January 8, 1997.

626. Lizama F and Naranjo G., "Utlización del palangre ...," p. 45.

627. "Cómo mantener el auge de la albacora en Estados Unidos," *Mercurio*, March 11, 1988, p. 7.

628. Carlos Capurro, Economic Section, U.S. Embassy, personal communications, July 29, 1987.

629. Yáñez and García, "La pesquería ...," *op. cit.*

630. Lizama F. and Naranjo G., "Utilización del palangre ...," *op. cit.*, p. 43.

631. "Chile's sword landings soar," *Seafood Leader*, Summer 1988, pp. 14, 16.

632. "South America imports: A series of false starts," *Seafood Business*, May-June 1988.

633. "Chile orders keep Marco busy," *Fishing News International*, November 1988, p. 62.

634. Peter Wadsworth as cited in "Chile's sword landings soar," *Seafood Leader*, Summer 1988, p. 14.

635. "Seafood market," *Seafood Leader*, Summer 1988, p. 6. Available annual data shows fresh prices increased in 1987 and then leveled off in 1998 which suggests a decline during late 1988. Prices then fell substantially in 1989 and 1990 (appendices G4a and J3a1).

636. Reyes, "Pesquería y mercado ...," *op. cit.*, p. 31.

637. "Conflicto en la pesca de pez espada," *Chile Pesquero*, May-June, 1988.

638. "Cómo mantener el auge ...," *op. cit.*, p. 7.

639. IFOP, "Descripción de la pesquería ...," *op. cit.*, p. 6.

640. Silva Martínez, *op. cit.*, December 12, 1996.

641. "Nuevo buque para pez espada y mero," *Chile Pesquero*, July-August, 1989, pp. 10-11.

642. Schaefer, *op. cit.*, December 20, 1996. Captain Defeo reported disappointing fishing off the northern coast, but some encouraging results off the central coast, despite having only limited time. Captain Rick Defeo, *op. cit.*, July 24, 1997.

643. Chilean data shows a similar price decline (appendix G4a).

644. "Good availability, moderate prices," *Seafood Leader* May-June 1990, p. 8.

645. "Problemas con la pesquería del pez espada o 'albacora'," *Chile Pesquero*, April-May 1990, p. 12.

646. Yáñez and García, "La pesquería ...," *op. cit.*

647. The authors have noted different Chilean estimates of effort (appendices C2a1-3). While the numbers vary, all show a substantial increase in 1991.

648. "Growing fresh and frozen catch: 1,000 boats on swordfish," *Fishing News International*, April 1992, p. 31.

649. IFOP, "Descripción de la pesquería ...," *op. cit.*, p. 6.

650. There are substantial discrepancies between Chilean export data and U.S. (the main importer) import data (appendix J2d). The authors in this report have chose to rely primarily on the Chilean data which appears to be more accurate. This may in part be due to the fact that the U.S. data does not include substantial quantities of the processed swordfish products, some of which may be classified as fillets or other miscellaneous marine fish products. Stephen Koplin, NMFS, personal communications, December 27, 1996. Chile, unlike most other Latin American countries, processes substantial quantities of swordfish instead of merely shipping most of it as unprocessed trunks. (See: "Processing and Products.")

651. Other estimates provide different numbers, but confirm a similar trend (appendix C2a1-3).

652. "Chile," *INFOPESCA Noticias Comerciales*, June 20, 1992.

653. Kameya, *op. cit.*, August 14, 1997.

654. Chilean data shows a substantial price increase during 1992 (appendix G4a).

655. Erich Schaub, "Una variable clave es la comercialización," *Chile Pesquero*, N°78, 1993, pp. 55, 59-60.

656. "Barometro de los mercados," *Chile Pesquero*, September-October, 1993, p. 61.

657. Silva Martínez, *op. cit.*, December 12, 1996.

658. IFOP, "Descripción de la pesquería ...," *op. cit.*, p. 6.

659. Some sources shows relatively stable effort (appendix C2a2), but others show declining effort (appendix C2a3).

660. Silva Martínez, *op. cit.*, December 12, 1996.

661. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 29.

662. Covarrubias, *op. cit.*, September 17, 1997.

663. Donoso, *op. cit.*, September 10, 1997. It is unclear why prices impaired artisanal operations as available data show no significant price decline (appendix G4 and J2h1).

664. Salas, *op. cit.*, September 1, 1997.

665. Silva Martínez, *op. cit.*, December 12, 1996.

666. Covarrubias, *op. cit.*, September 17, 1997.

667. Miguel Donoso, IFOP, personal communications, September 10, 1997.

668. Salas, *op. cit.*, September 1, 1997.

669. Clavería, *op. cit.*, April 12, 1996 and Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 203.

670. Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, p. 27.

671. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 206.

672. Yáñez and García, "La pesquería ...," *op. cit.*

673. The large Chilean catch increases (appendix E2a2) do not appear to have caused major price fluctuations (appendices G4a and J3a1).

674. See for example "Nuevo buque para pez espada y mero," *Chile Pesquero*, July-August, 1989, pp. 10-11.

675. Catch fluctuations can be caused by various fishery-independent factors such as climate or pollution. In addition, given the highly migratory nature of swordfish, it is possible that fishing pressure at other sectors of the fish's migratory track may be having more impact than that of Chilean fishermen.

676. Barbieri, *op. cit.*, December 19, 1996.

677. Clavería, *op. cit.*, April 12, 1996.

678. Wadsworth, *op. cit.*, November 12, 1996.

679. Clavería, *op. cit.*, April 12, 1996.

680. Wadsworth, *op. cit.*, November 12, 1996.

681. Wadsworth, *op. cit.*, November 12, 1996.

682. Jaime Azócar, Manager/Owner, Pesquera Santo Domingo, personal communications, November 15, 1996 and Chong, *op. cit.*, December 4, 1996.

683. Yáñez and García, "La pesquería ...," *op. cit.* and Heriberto Muñoz Concha, processing plant owner, personal communications, November 20, 1996.

684. For details see the Peruvian chapter of this report.

685. Muñoz Concha, *op. cit.*, November 20, 1996; H.L. Schmidt, *op. cit.*, April 8, 1996; and Wadsworth, *op. cit.*, April 16, 1996.

686. Kameya, *op. cit.*, August 14, 1997. Chilean observers are also assessing the impact of climatic trends on swordfish. González, Barbieri, and Yáñez, "Distribución espacio temporal ...," *op. cit.*

SECTION VIII. (Ports)

687. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. iv.

688. The larger catch outside 200-miles is not broken down by port (appendix E2e1).

689. U.S. Embassy, Santiago, "GO denies allegation that it permits Taiwanese transshipment of swordfish," message number 5996, January 14, 1993.

690. A review of the local fishing industry is available in Fernando Stumptner M., "Caldera: Otra vez en la ruta del progreso," *Chile Pesquero*, October, 1986, pp. 27-32.

691. SERNAP, *Anuario Estadístico Pesquero*, 1996 *op. cit*, p. 1. Time-line data on the Constitución longliners are available in (appendix A3d and figure 74). The Constitución longliners are noted as "Central" in the appendix and graphic.

692. Bornscheuer, *op. cit.*, October 4, 1997.

693. Uribe and Salazar, "Swordfish (*Xiphias gladius*) catch distributions ...," *op. cit*, pp. 851-857.

694. Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, p. 29 and IFOP, "Descripción de la pesquería ...," *op. cit.*, p. 4.

695. Almost all of the Chilean catch is taken within the 200-mile zone and fisheries conducted beyond the 200-mile limit are unusual. As a result, regulations requiring the fishermen to report their catch do not cover operations beyond 200-miles. SERNAP officials plan to change the regulations and this data should be available in the future. Bornscheuer, *op. cit.*, October 4, 1997.

696. Miguel Zuvic Mujica, Chief of Development and Negotiations, Empresa Portuaria de Chile: Coquimbo. Personal communications, April 8, 1996.

697. Empresa Portuario de Chile, "Coquimbo Ciudad Puerto," 1996.

698. Zuvic Mujica, *op. cit.*, April 8, 1996.

699. "Coronel in new build-up," *Fishing News International*, February, 1993, p. 48.

700. A good recent overview of the port is available in Antonio Aranis R., "Presente y futuro de la industria pesquera de San Antonio," *Boletín Informativo SIM*, N°32, September, 1995, pp. 10-14.

701. Clavería, *op. cit.*, April 12, 1996.

702. "Incremento en el sector pesquero de San Antonio," *Chile Pesquero*, August, 1986 and "Chile port start-up hits delay," *Fishing News International*, October, 1993, p. 53. A good review of the fishing industry in San Antonio is available in Jaime Barrientos, interviewed by Antonio Aranis R., "Presente y futuro de la industria pesquera de San Antonio," *Boletín Informativo SIM*, September, 1995, pp. 10-14.

703. Bornscheuer, *op. cit.*, October 4, 1997.

704. Alejandro Bermejo, "Boom harinero en area de Talcahuano (Chile)," *Pesca*, May-June, 1987, pp. 6-12.

705. For details on Chile's salmon culture industry see William Folsom, *World Salmon Culture* (NMFS: Silver Spring, Maryland, 1992).

706. Detailed statistics showing the small swordfish landings in Valparaíso are available in SERNAP, *Anuario Estadístico de Pesca*, various years.

707. IFOP, "Descripción de la pesquería ...," *op. cit.*, p. 4.

708. Zuvic Mujica, *op. cit.*, April 8, 1996.

709. Chilean Embassy (Washington), "Ports: Ships Ahoy!," *Chile*, September 4, 1996, p. 1.

SECTION IX. (Transshipments)

710. Ley N°430, September 28, 1991 which refined, coordinated, and systemized the Ley General de Pesca y Acuicultura, Ley N°18.892 of 1989.

711. Chile is preparing to implement a satellite vessel monitoring system (VMS). SERNAP has been conducting tests with the Argos system. About 46 percent of the vessels that will be involved are working fishing vessels. Besides the potential benefits for Chilean fisheries management, Chilean officials see some important benefits for the country's fisheries research program. It is very expensive to station observers aboard foreign fishing vessels. With a VMS system, important data could be collected on foreign operations at relatively low cost. Chilean officials are particularly interested in promoting the development of a tuna fishery and see a VMS system as a inexpensive way of collecting data from Japanese tuna longliners. Roberto Bahamondes, IFOP, Comments at the United States-Chile Fishery Cooperation Talks, Santiago, Chile, April 1-2, 1996.

712. Covarrubias, *op. cit.*, January 28, 1996.

713. Covarrubias, *op. cit.*, January 28, 1996.

714. A U.S. fishermen charged in 1993 that Taiwan fishermen were transhipping swordfish through Arica. SERNAP officials insist that there are no swordfish transshippers, although the Taiwan fishermen could transship tuna. The Taiwan fishermen are also allowed to call at Arica to purchase supplies. U.S. Embassy, Santiago, "GOC denies allegation that it permits Taiwanese transshipment of swordfish," message number 5996, January 14, 1993. For information on Ilo and transhipping activities there see the Peruvian chapter of this report.

715. "Latest visitors to SAEM of Chile," *World Fishing*, January 1993, p. 33.

716. Alejandro Covarrubias, Director de Fiscalización, SERNAP, Comments at the United States-Chile Fishery Cooperation Talks, Santiago, Chile, April 1-2, 1996.

717. Covarrubias, *op. cit.*, January 28, 1996.

718. "Prosiguen las protestas de las armadores de la flota palangera congeladora," *Industrias Pesqueras*, April 15, 1991, p. 35 and "Los armadores de barcos palangeros contrarios a la actitud de las autoridades chilenas," *Industrias Pesqueras*, March 15, 1991, p. 31.

719. For details see the Peruvian chapter of this report.

720. Kirt Blinsinger, personal communications, August 28, 1995.

721. Some limited information is summarized in the Uruguayan chapter of this report.

722. SERNAP confirms that this is probably the swordfish being landed by the Chilean longliners operating out of Montevideo. Covarrubias, *op. cit.*, September 17, 1997. Note that the exports are product weight (trunks), the export totals would have to be adjusted to convert to liveweight. The trunks are about 70 percent of the liveweight.

723. Covarrubias, *op. cit.*, April 2, 1996.

SECTION X. (Processing and Products)

724. IFOP, "Recurso albacora," *op. cit.*, p. 2.

725. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 211.

726. The small bongos and faluchos do not have holds, but these now represent a very small part of the Chilean catch.

727. Herman Carvajal León, Region IV Director, SERNAP, personal communications, April 9, 1996 and Clavería, *op. cit.*, April 12, 1996.

728. "South American imports: A series of false starts," *Seafood Business*, May-June 1988.

729. Reyes, "Pesquería y mercado ...," *op. cit.*, p. 32.

730. Juan Luis Arias, "El mercado americano del pez espada (albacora): Su evolución e implicaciones para Chile," *Boletín Informativo SIM*, N°19, May 1992, p. 5.

731. SERNAP statistics on the output of finished product show a comparable pattern (appendix G3a).

732. Carrasco, *op. cit.*, November 6, 1996. This means that often the females and fish taken with harpoons are often used for further processing. Clavería, *op. cit.*, April 12, 1996.

733. Jaime Azócar, Owner, Pesquera Santo Domingo, personal communication, January 23, 1997.

734. Barbieri, *op. cit.*, April 11, 1996.

735. Azócar, *op. cit.*, November 15, 1996 and Leonard Muga, Sales Manager, New Bay Products, personal communications, November 15, 1996.

736. Actual production data is unavailable by specific product form. IFOP does, however, publish data on exports by product form. As most of the Chilean catch is exported, the authors believe that the export data provide a close approximation to actual production.

737. Wadsworth, *op. cit.*, November 12, 1996.

738. Rodrigo Polanco Z., Subsecretaría de Pesca, personal communications, September 22, 1997.

739. Rungis market report," *INFOFISH Trade News*, July 16, 1990.

740. Wadsworth, *op. cit.*, November 12, 1996.

741. Hernández, "Informaciones ...," *op. cit.*

742. Some of the fish which can not be exported is fish that is essentially good quality, but may have imperfections such as a small shark bite on part of the trunk.

743. The study also assessed smoked swordfish which has been produced in small quantities. Adela Mansilla, "Utilización de desechos de albacora en productos para consumo humano," (IFOP N° inven: 890048), December 1989.

744. SERNAP data for the output of processed product by region show a similar pattern. See the G3b series appendices.

745. The discrepancies between Chilean export data and U.S. import data are described in the "Markets: Trade" section of this report. The authors believe that the Chilean export data may be the more accurate data set. The U.S. import data does not seem to include all the product shipped. For this reason the authors have used the Chilean data to derive nominal prices.,

746. H. Schmidt, *op. cit.*, April 8, 1996.

747. Jorge Schmidt, Manager, Importadora y Exportadora Nanaimo, personal communications, December 18, 1995.

748. Salas, *op. cit.*, September 1, 1997.

SECTION XI. (Organizations)

749. Most of the Chilean fleet is operated by artisanal fishermen. While companies do not own these vessels, they have a variety of arrangements with the artisanal fishermen.

750. Antonio Aranis R., "Vision de sector pesquero," *Boletín Informativo SIM*, No. 35, June 1996, pp. 20-21.

751. Wadsworth, *op. cit.*, December 8, 1995.

752. One good example is Compañía Pesquera Camanchaca which is a large diversified producer of fishmeal, canned fish, and a variety of other fishery products. The company expanded into salmon aquaculture and now produces substantial quantities of fresh and frozen salmon and trout.

753. "Growing fresh and frozen catch: 1,000 boats on swordfish," *Fishing News International*, April, 1992, p. 31.

754. José I. Ruz, Andes Sur, personal communications, December 11, 1995.

755. Capurro, *op. cit.,* July 29, 1987.

756. Juan Reutter, General Manager, Cisandina, as cited in Reyes, "Pesquería y mercado ...," *op. cit.*, p. 32.

757. Marcelo Adduard, Export Manager (Latin America), Commercial Cisandina, personal communications, January 22, 1997.

758. Adduard, *op. cit.*, February 27, 1997.

759. Olesen, "Informe al gobierno ...," *op. cit.*, p. 41.

760. Eduardo Neff as cited in "Chile's sword landings soar," *Seafood Leader*, Summer 1988, pp. 14, 16.

761. A glossary of the Spanish and scientific species names are available in appendix L1.

762. Humberto Contreras, EMPAC, personal communications, December 18, 1995.

763. Jorge Schmidt, Manager, Importadora y Exportadora Nanaimo, personal communications, December 18, 1995.

764. J. Schmidt, *op. cit.*, December 18, 1995.

765. Heriberto Muñoz Concha, processing plant owner, personal communications, November 20, 1996.

766. Leonard Muga, Sales Manager, New Bay Products, personal communications, November 15, 1996.

767. Jaime Hidalgo, Ocean Resources, in Reyes, "Pesquería y mercado ...," *op. cit.*, p. 32.

768. Inés Ponce, Treasurer, Pesquera Omega, personal communications, January 22, 1997.

769. Sub-Secretaría de Pesca (SSP), "Informe primer trimestre resoluciones emitidas," period January 1-March 31, 1997, p. 3.

770. Covarrubias, *op. cit.*, August 18, 1995.

771. SSP, "Informe primer ...," period January 1-March 31, 1997, p. 5.

772. SSP, "Informe primer ...," January 1-March 31, 1997, *op. cit.*, p. 13.

773. Peter Wadsworth, Owner/Manager, Pesquera Catalina, personal communications, December 8, 1995. The first reported U.S. imports were in 1983, but small quantities could have entered under general basket categories.

774. Pesquera Catalina, "Desarrollo de una pesquería artesanal de mediana altura en la zona central," Informe Final, 1982, volumes I and II as cited in Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 206.

775. Peter Wadsworth, Owner/Manager, Pesquera Catalina, personal communications, November 12, 1996.

776. The company reports that the vessels are 32-m long and 300 GRT. Data published by EDITEC (appendix A3b) indicates a slightly smaller size.

777. Carrasco, *op. cit.*, November 6, 1996.

778. Silva Martínez, *op. cit.*, December 12, 1996.

779. Silva Martínez, *op. cit.*, April 8, 1996.

780. Carrasco, *op. cit.*, November 6, 1996.

781. SSP, "Informe primer ...," January 1-March 31, 1997, *op. cit.*, p. 11.

782. "New line in frozen bait," *Fishing News International*, February 1991.

783. For details on this fishery see William Gibbons-Fly and Dennis Weidner, "South American centolla fishery," *International Fishery Reports*, (IFR-85/71), December 20, 1985.

784. John Beck, Manager, Pesquera Isla del Rey, personal communications, November 20, 1996.

785. Antonio Macol, Manager, Pesquera Lacks, personal communication, November 20, 1996.

786. Anonymous Pesquera Marazul official, personal communications, November 19, 1996. The company representative asked that he not be cited by name in the report. Marazul reports that the four longliners were in late 1996 operating off Argentina under the Argentine flag. The authors note that the vessels were also been licensed for swordfish operations off Chile in 1996 (appendix A3b).

787. Azócar, *op. cit.*, November 15, 1996.

788. Anonymous Pesquera Marazul official, *op. cit.*, November 19, 1996.

789. "Growing fresh and frozen catch: 1,000 boats on swordfish," Fishing News International, April, 1992, p. 31.

790. Hans Louis Schmidt, General Manager, Pesquera Omega, personal communications, April 8, 1996.

791. The importance of the company's swordfish shipments by quantity is smaller than by value (appendix H1a). This indicates that Pesquera Omega ships a relatively high proportion of unprocessed H&G trunks.

792. H. Schmidt, *op. cit.*, April 8, 1996.

793. Sebastian Vera, Gerente General, Pesquera Omega, personal communications, April 2, 1997.

794. Cristóbal Anusch, Controller, Pesquera Omega, personal communications, November 21, 1995.

795. Vera, *op. cit.*, April 2, 1997.

796. SSP, "Informe primer ...," January 1-March 31, 1997, *op. cit.*, p. 3.

797. Uribe and Salazar, "Swordfish (*Xiphias gladius*) catch distributions ...," *op. cit*, pp. 851-857.

798. Artemio Caro, Pesquera Santa Lucia, personal communications, November 6, 1996.

799. It is unclear why the company list does not agree with available published lists of major exporters (appendix H1a).

800. Jaime Azócar, Manager/Owner, Pesquera Santo Domingo, personal communications, November 15, 1996.

801. SSP, "Informe primer ...," January 1-March 31, 1997, *op. cit.*, p. 11.

802. Azócar, *op. cit.*, November 15, 1996. The vessel was previously operated by Pesquera Santa Ana.

803. Ponce, *op. cit.*, November 12, 1996.

804. Héctor Bacigalupo, SONAPESCA, personal communications, November 12, 1996.

805. Sociedad Nacional de Pesca (SONAPESCA), *SONAPESCA Memoria Anual*, 1995, p. 12.

806. Quezada, *op. cit.*, January 22, 1997

807. Clavería, *op. cit.*, April 12, 1996.

808. Clavería, *op. cit.*, April 12, 1996.

809. A brief overview of the market for fresh seafood in Chile is available in Alfonso Irarrázabal y Elizabeth Palta, "El mercado de productos del mar frescos en Chile," *Boletín Informativo SIM*, No. 29, November, 1994, pp. 10-12.

810. Eduardo Viveros Opazo, Director de Fiscalización, Region IV, SERNAP, personal communications, April 7, 1996.

811. M.P. Hernández, *Informaciones Estadísticas Sobre Pesca*," Dirección de Pesca y Caza, Valparaíso, 56p. as cited in Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 204.

812. Farrington, *Fishing the Pacific, op. cit.*, p. 51.

SECTION XII (Markets)

813. Carrasco, *op. cit.*, November 6, 1996.

814. The authors during 1994 and 1996 trips to Chile never saw any swordfish being sold at the ports or in markets and supermarkets. Swordfish does, however, appear on the menu of some upscale restaurants in Santiago.

815. Chilean export data (appendix J2e) and U.S. import data (appendix J3a1) show substantial differences which are not fully understood. The authors believe that the U.S. Customs Service may not be identifying all of the swordfish exported by Chile. Most Latin American countries export swordfish primarily as relatively easily identifiable trunks. Chilean companies, however, are processing substantial quantities of swordfish and some of the resulting fillets, loins, and other products may be included in various basket categories for unspecified marine fish. Koplin, *op. cit.*, December 27, 1996. As a result, the authors are using Chilean export data rather than U.S. import data.

816. Apparent U.S. prices also show a decline of prices for frozen swordfish in 1993, but improving prices in 1994-95 (appendix J3a1). Part of this discrepancy may be explained by anomalies due to the increasingly small quantity of frozen product imported by the United States in 1994 and especially 1995 (appendix J3a2).

817. For details on the U.S. fishery and market, see the U.S. chapter of this report.

818. The seasonality of Hawaiian landings, however, are more similar to the Chilean patterns. Arias, "El mercado americano ...,' *op. cit*, p. 4.

819. As explained above, the authors have decided to use Chilean export data rather than U.S. import data because the Chilean data appears more accurate. The United States is planning changes in the Customs categories which will, in the future, provide more detailed data on swordfish imports.

820. Canadian exports to the United States fell sharply in 1996 and the total value was less than that of the Chilean shipments. Canada still ranked second in value, although Costa Rica actually shipped more product to the United States (appendix J3e2). For details on the Canadian fishery, see the Canadian chapter of this report.

821. Jerome Erbacher, NMFS, personal communications, September 10, 1997.

822. State of Hawaii, Department of Business, Economic Development & Tourism, Ocean Resources Branch, "Shutome: Braodbill swordfish," WWW posting, January 31, 1997.

823. Japan has no customs category specifically for swordfish. Swordfish is included in a general billfish category. The authors, however, believe that because other billfish have more tropical ranges, they are less common in Chilean waters. Thus most all the exports to Japan in the billfish category are swordfish.

824. Azócar, *op. cit.*, January 23, 1997

825. Rungis market report," *INFOFISH Trade News*, July 16, 1990.

826. Covarrubias, *op. cit.*, September 17, 1997.

827. Polanco, *op. cit.,* September 22, 1997.

SECTION XIII. (Government Agencies and Policies)

828. Ponce Martínez and Bustos, "La pesquería ...," *op. cit.*, p. 27.

829. See for example "Nuevo buque para pez espada y mero," *Chile Pesquero*, July-August, 1989, pp. 10-11.

830. Covarrubias, *op. cit.*, April 12, 1996.

831. Vilma Correa, Subsecretaría de Pesca, comments at the United States-Chilean Cooperative Fishery Talks, July 24, 1997.

832. Supreme Resolution 179, April 14, 1953.

833. Ministerio de Relaciones Exteriores statement, September 12, 1985.

834. Robert W. Smith, *Limits in the Seas*, No. 36, 6th revision (U.S. Department of State: Washington, D.C., January 3, 1990), p. 30; *La Segunda*, June 27, 1986; *El Mercurio*, July 2, 1986; and U.S. Embassy, Santiago, "GOC response to U.S.-nonrecognition of 350-mile zone of sovereignty," message number 4230, July 2, 1986.

835. Ley N°18.565, October 26, 1986.

836. IFOP, "Recurso albacora," *op. cit.*, p. 1.

837. Ponce, *op. cit.*, January 8, 1997.

838. Donoso, *op. cit.*, December 20, 1996.

839. Achurra, "El intenso esfuerzo ...," *op. cit.*, pp. 18-19.

840. Ley 18.480. The rebates were gradually reduced as shipments increased: up to $11. 6 million (10 percent), up to $17.4 million (5 percent), and up to $20.9 million (3 percent). Covarrubias, *op. cit.*, January 28, 1997.

841. Azócar, *op. cit.*, January 16, 1997.

842. Marisol Quintana P. and Sergio Pino A., "IFOP ofrece a los exportadores un sistema de información pesquera en apoyo de su gestión exportadora," *Boletín Informativo SIM*, N°38, March 1997, pp. 16-19.

843. M.A. Barbieri, F. Naranjo, E. Yáñez, M. Farías, G. Danneri, and P. Rojas, "La pesquería artesanal de atún aleta larga en la zona de Valparaíso y el satélite NOAA," *Invest. Mar.*, Valparaíso, 1987, Vol. XV, pp. 14-61 and Martínez, "Prospección ...," *op. cit.*.

844. SERNAP defines artisanal fishing as fish harvesting activities personally conducted by individuals who habitually work as fishermen and whose vessels are not larger than 18 meters or 50 GRT. SERNAP identifies four categories of artisanal fishermen: boat owner ("armador"), shellfish fisherman ("mariscador"), artisanal fishermen ("pescador artisanal propiamente tal"), and seaweed gatherers ("algueros"). These fishermen can conduct more than one artisanal activity as long as it is all done in the same region. SERNAP maintains a Registro Nacional de Pescadores Artesanales (Registro Artesanal) to identify these fishermen. Covarrubias, *op. cit.*, October 17, 1995.

845. Correa, *op. cit.*, July 24, 1997 and October 17, 1997.

846. Decreto Supremo 293, DO October 15, 1990.

847. One such action was Resolución No°1225, December 30, 1994. The situation is reviewed annually and new regulations issued each year if the fishery needs to remain closed to new entrants.

848. As noted above, a Chilean Region is an official administrative unit, but without the vested authority of a state.

849. The area of operation for the artisanal vessels was extended in 1992. Subsecretaría de Pesca (SSP), Resolución N°135, February 25, 1992. It is annually updated. The most recent update was SSP, Resolución 2167, December 26, 1997.

850. Decreto Supremo 293, *Diario Oficial*, October 15, 1990.

851. Decreto N°293/95.

852. DS Min. RR. EE. 1.516, March 3, 1994. The United Nations Driftnet Moratorium which went into effect December 31, 1992 is U.N. Resolution 46/215.

853. Justen, *op. cit.*, October 18, 1995 and H. Schmidt, *op. cit.*, April 8, 1996.

854. Vilma Correa, Sub-Secretarı'a de Pesca, personal communications, October 10 and 17, 1997. Some researches estimate that 106 cm fish could be even smaller. NMFS researchers report that while they make many measurements on swordfish, they do not measure from the front of the first dorsal fin to the back of the second dorsal fin as specified in the new Chilean regulations. They do take a measurement from the front of the first dorsal to the front of the second dorsal fin. Based on 148 measurements taken at sea on the NOAA research

vessel *Townsend Cromwell*, the following rough estimates were derived. One, front of the first dorsal to front of the second dorsal, 106 cm is equivalent to about 78 kilograms. If we assume that the base of the second dorsal fin is about 6 cm (rough estimate since measurements on the base of the fin are not available and none are known in the literature), than an equivalent measurement from the front of the first dorsal to the front of the second dorsal would be 100 cm for a 106 cm fish measured from the front of the first dorsal to the rear of the second dorsal fin. The minimum sized fish specified in the Chilean regulations would thus weigh an estimated 65 kg whole (95 percent CI of predicted weight is plus or minus 15 kg). There is, however, considerable variations in weights at this size and the fish were weighed at sea. A 101 cm fish is about 67 kg whole. NMFS researchers caution that the weights were made at sea, where conditions are often not minimal for careful measurement. Other published reports of swordfish weight/length equivalents also show considerable variation, so the variations observed were normal. The sea conditions could have affected the weight measurements. James Uchiyama, NMFS Southwestern Fisheries Science Center, Honolulu, personal communications, October 9, 1997.

855. The ICCAT Commission in 1991 adopted a prohibition on taking and landing Atlantic swordfish weighing less than 25 kg live weight (125 cm lower jaw fork length), but allowing Contracting Parties to grant a 15 percent tolerance of small fish in number of fish to boats that incidentally catch swordfish. ICCAT has also encouraged Contracting Parties to take other appropriate measures within their national jurisdictions to protect small swordfish. Some Contracting Parties reported that the tolerance made it difficult to enforce the ICCAT management regime recommended by ICCAT's Scientific Committee for Research and Statistics (SCRS). As a result, the ICCAT Commission approved new recommendations in 1995 for a more easily enforced management regime. The new recommendations permitted fishermen to take even smaller fish (119 cm from the tip of the lower jaw to the tail fork--LJFL--or the equivalent in weight), but provided no tolerance of swordfish smaller than this minimum. Countries choosing this alternative must require appropriate record keeping of discards. ICCAT, "Annex 4-10," *ICCAT Report, 1994-95*, Vol. II, p. 88. The 119 cm LJFL measurement is equivalent to a cleithrum to caudal keel measure (CK) of 73 cm or 15 kilograms. "Atlantic swordfish fishery; 1996 quotas, minimum size, adjustment," 50 CFR Part 630, final rule, *Federal Register*, May 31, 1996, pp. 27304-27305.

856. A precise assessment is not possible as the new regulations specify a trunk weight for which data is not available to the authors. Much of the commercial catch appears to be fish with the H&G trunks under 50 kg and the average about 33 kg (appendix B5g1 and 3). Given the small sized fish reported by the commercial fishermen, however, a considerable adjustment in fishing operations may be required. For details on the sizes taken by the commercial fishermen see: "Species: Size variations".

857. Resolución N°406, April 2, 1997.

858. Decreto Supremo 293, DO October 15, 1990, Article 9.

859. The fine was set at 90.7 unidades tributarios mensuales (UTM) per ton of swordfish. Decreto N°66, January 27, 1995.

860. The fine was increased to 112.2 unidades tributarios mensuales (UTM) per ton of swordfish. Decreto N°39, January 29, 1997, published in the *Diario Oficial*, March 17, 1997.

861. The higher fines are for: puye (213 UTM), salmon (122 UTM), and marine mammals and birds (300 UTM). Decreto N°39, January 29, 1997.

862. See the individual country chapters for details.

863. The debate over the catch decline is discussed in "Catch."

864. Nelson Plaza, Maritime Workers Federation, Coquimbo, cited in Gabriel Canihuante, "Fisheries-Chile: Problems with new treaty," Inter Press Service English News Wire, January 11, 1996.

865. Burgos, *op. cit.*, January 27, 1997.

866. Juan Rojas, President of the Coquimbo Fishing Union, as cited in Canihuante, "Fisheries-Chile..." *op. cit.*

867. A variety of species are taken in the driftnets, but the authors have little statistical information on the by-catch. Some information is available, however, on turtles. (See "By-catch.") See the description of the U.S. market above ("Markets: Trade") for details on the demand for small fish.

868. Schmidt, *op. cit.*, April 8, 1996.

SECTION XIV. (Research)

869. Rodolfo Serra, IFOP, comments at United States-Chile Fishery Cooperation Talks, La Jolla California, March 20, 1995.

870. "Editorial," *Boletín Informativo SATAL*, March 1988 and Jaime Arancibia, Systems Specialist, Centro de Estudios Espaciales, Universidad de Chile, personal communications, January 29, 1997.

871. Barbieri, *et. al.*, "Monitoreo de la pesquería ..., 1994," *op. cit.*, p. 3.

872. Martínez, "Prospección ...," *op. cit.*

873. Lizama F. and Naranjo G., "Utilización de palangre ...," *op. cit.*, p. 45.

874. Barbieri, *et. al.*, "La pesquería artesanal ...," *op. cit.*

875. IFOP, "Descripción de la pesquería ...," *op. cit.*, p. 1.

876. Donoso and Serra, "La pesquería ...," *op. cit.*, pp. 6-7.

877. See the listings for Barbieri and Donoso in the bibliography.

878. Barbieri, *et. al.*, "Monitoreo de la pesquería ...," *op. cit.*

879. Ponce, *op. cit*, January 8, 1997. A good overview of IFOP conclusions through 1995 on the status of the fishery is available in IFOP "Descripción de la pesquería ...," *op. cit.*

880. IFOP, *Memoria, 1994* (IFOP: Valparaíso, 1995).

881. See for example Silva S., "Masas de agua ...," *op. cit.* and Sievers and Silva S. "Masas de agua ...," *op. cit.*

882. Barbieri *et. al.*, "La pesquería de pez espada ...," *op. cit.*, p. 203. Note that the authors have for ease of reference abbreviated the Universidad de Chile as "UC". Chileans, however, commonly refer to it as the "U".

883. Uribe and Salazar, "Swordfish (*Xiphias gladius*) catch distributions ...," *op. cit*, pp. 851-857.

884. Donoso and Chong Lay-Son, "Determinación de edad ...," *op. cit.*

885. "¿Que es el proyecto," *Boletín Informativo SATAL*, March, 1988, p. 2.

886. Donoso and Serra, "La pesquería ...," *op. cit.*, p. 5.

887. Barbieri, *et. al.* "La pesquería artesanal ...," *op. cit.*, pp. 14-61 and Yáñez, *et. al.*, "Temperatura superficial ...," *op. cit.*

888. Barbieri, *et. al.*, "La pesquería del pez espada ..., *op. cit.*, p. 195 and Barbieri, *op. cit.*, January 29, 1997.

889. González, Barbieri, and Yáñez, "Distribución espacio temporal ...," *op. cit.*

890. One exception to that tendency is Pesquera Catalina which helped introduce driftnets to the Chilean fishery. Pesquera Catalina, "Desarrollo de una pesquería artesanal...," *op. cit.*

891. "¿Ques es el proyecto? *Boletín Informativo SATAL*, March 1988, p. 2.

892. Lizama and Naranjo, "Utilización del palangre ..., " *op. cit.*, p. 45.

893. JAMARC, "Report on 1979 tuna longline fishing ...," *op. cit.*

894. Manning, "Summary of investigations ...," *op. cit.*

895. Mike Laurs, NMFS Honolulu Laboratory, personal communications, July 3, 1997.

896. Donoso and Chong Lay-Son, "Determinación de edad ...," *op. cit.*, p. 9.

897. Chong, *op. cit.*, December 4, 1996.

SECTION XV. (By-catch)

898. Yáñez, *op. cit.*, January 22, 1997.

899. A good review of Chile's small tuna fishery is available in Gonzalo Muñoz H., "Pesca de atunes frente a las costas de Chile y sus exportaciones," *Boletín Informativo SIM*, N°38, March 1997, pp. 13-15.

900. Clavería, *op. cit.*, April 12, 1996. Tuna are landed in the same ports that the swordfish is landed in and catches have declined in recent years as swordfish landings have fallen.

901. Silva Martinez, *op. cit.*, December 12, 1996.

902. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*

903. Reiger, *Profiles ...*, *op. cit.*, pp. 152-154.

904. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 8-11.

905. Chong, *op. cit.*, December 4, 1996.

906. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*

907. Doyle A. Hanan, David B. Holts, and Atilio L. Coan, Jr., "The California drift gill net fishery for sharks and swordfish, 1981-82 through 1990-91," *Fish Bulletin*, 175 (California Fish and Game: Sacramento, 1993), p. 26.

908. This appears to be the general pattern reported by foreign fishermen, although stripped marlin is reported at latitudes in the eastern Pacific as far south as 35-40°S. Carocci and Majkowski, *Pacific Tunas and Billfishes, op. cit.*, map 8-11. Recreational fishermen active in the 1930-50s reported the best fishing off the northern coast.

909. Farrington, *Fishing the Pacific*, *op. cit.*, p. 38.

910. Silva Martinez, *op. cit.*, December 12, 1996.

911. Clavería, *op. cit.*, April 12, 1996; Azócar, *op. cit.*, January 16, 1997; Yáñez, *op. cit*, January 22, 1997.

912. Recent work describing cetaceans along the central coast, where until 1996 the swordfish fishery was centered, include: José Brito L. and Julio C. Reyes, " Registro de cetaceos en aguas de Chile central," 4ª Reunion de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur, November 12-15, 1990, Valdivia, Chile and José Brito L., "Nuevos registros de cetáceos para las aguas de Chile central," and A. Aguayo, R. Bernal, C. Olavarría B., V. Vallejos M., and R. Hucke G., "Observaciones de cetáceos realizadas entre Valparaíso e Isla de Pasca, durante el invierno de 1993, 1994 y 1995," in 7ª Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur/1° Congreso de la Sociedad Latinoamericana de Especialistas en Mamíferos Acuáticos, October 22-25, 1996, Viña del Mar, Chile.

913. Brito, "Nuevos registros ...," *op. cit.*

914. H.L. Schmidt, *op. cit.*, April 8, 1996.

915. Bailey, *et. al.*, "Bycatch and discards ...," *op. cit.*, p. 4.12.

916. Dollar, "Annual report ...," pp. 24-25.

917. Doyle A. Hanan, David B. Holts, and Atilio Coan, "The California drift gillnet fishery for sharks and swordfish, 1981-82 through 1990-91," *Fish Bulletin* (California Department of Fish and Game), No. 175, 1993, p. 26.

918. There has been one sighting as far north as 55°S. Anelio Aguayo, Rene Maturana C., and Daniel Torres N, "Antarctic fur seal, *Arctocephalus gazella* (Peters), in the Chilean Antarctic sector," source document unavailable.

919. The historical range of this species appears to be primarily southern Chile, but in recent years the species has been noted in northern Chile. The full range of the species extends to central Peru. Daniel Torres, Carlos Guerra, and Michael Sallaberry. "Registros de *Artocephalus australis* en Antofagasta II Región, Chile, y comentarios sobre su distribución geográfica (Pinnipedia: Otariidae)," *Estud. Oceanol.*, Vol 3, No.1, pp. 31-40.

920. Chile has a large population of sea lions but the population of the Juan Fernández fur seal is very small. For details see Daniel Torres, "Juan Fernández fur seal, *Arctocephalus philippii*," in "Status, biology, and ecology of fur seals: Proceedings of an International Symposium and Workshop, Cambridge, England 23-27 April 1984," *NOAA Technical Report*, NMFS51, June 1987. pp. 37-41.

921. Several artisanal fishery organizations (Consejo Nacional de Pescadores Artesanales, Sindicato de Pescadores de Caleta Portales de Valparaíso, and Sindicato de Pescadores de Caleta Higuerilla) complain of the increasingly adverse impact of the growing pinniped populations. "La población de lobos marinos se cuadruplica," *El Mercurio*, April 20, 1987.

922. Chong, *op. cit.*, December 4, 1996.

923. Burgos, *op. cit.*, January 27, 1997.

924. Hanan, Holts, and Coan, "The California drift gill net fishery ...," *op. cit.*, pp. 23-26.

925. Bailey *et. al.*, "By catch and discards ...," *op. cit.*, table 4.7.

926. Dollar, "Annual report ...," pp. 24-25.

927. Yáñez, *op. cit.*, January 22, 1997. A review of sea turtles off Chile is available in J.G. Frazier and S. Salas, "Tortugas marinas en Chile," *Bol. Mus. Nac. Hist. Nat. Chile*, 1982, Vol. 39, pp. 63-73.

928. José Luis Brito Montero, Museo Municipal de Ciencias Naturales y Arqueologia de San Antonio, personal communications, March 16, 1997.

929. Jack Frazier, CINVESTAV, personal communications, February 23, 1997.

930. See for example Pamela T. Plotkin, Richard A. Byles, and David W. Owens, "Migratory and reproductive behavior of *Lepidochelys olivacea* in the eastern Pacific Ocean," in Barbara A. Schroeder and Blair E. Witherington, compilers, "Proceedings of the Thirteenth Annual Symposium on sea turtle biology and conservation," *NOAA Technical Memorandum*, NMFS-SEFSC-341 (NMFS-SEFSC: Miami, January 1994), p. 138 and Peter Dutton, Specialist on the molecular ecology of turtles, Comments at the United States-Mexico Fishery Cooperation Talks, Huatulco, Mexico, September 25, 1997.

931. James R. Spotila, Arthur E. Dunham, Alison J. Leslie, Anthony C. Steyermark, Pamela T. Plotkin, and Frank V. Paladino, "Worldwide population decline of Dermochelys coriacea: Are leatherback turtles going extinct?," *Chelonian Conservation and Biology*, Vol. 2, Number 2, October 1996, pp. 209-222.

932. Rene Marquez, National Turtle Coordinator (Mexico), Instituto Nacional de Pesca, presentation at the United States-Mexico Fishery Cooperation Talks, Huatulco, Oaxaca, Mexico, September 25, 1997.

933. Scott Eckert, Hubbs-Sea World Research Institute, personal communications, September 26, 1966. Details on leatherbacks and other species were also provided by Dutton, *op. cit.*, September 25, 1997 and Barbara Schroeder, National Turtle Coordinator, NMFS, personal communications, September 4, 1997.

934. Brito, *op. cit.*, March 16, 1997 and Rene Marquez, National Turtle Coordinator, Instituto Nacional de Pesca, Comments at the United States-Mexico Fishery Cooperation Talks, Huatulco, Mexico, September 25, 1997.

935. Eckert, *op. cit.*, September 26, 1997.

936. Clavería, *op. cit.*, April 12, 1996.

937. Chong, *op. cit.*, December 4, 1996 and July 18, 1997.

938. H.L. Schmidt, *op. cit.*, April 8, 1996 and Azócar, *op. cit.*, January 16, 1997.

939. Dutton, *op. cit.*, September 25, 1997; Barbara Schroeder, National Turtle Coordinator, NMFS, personal communications, September 4, 1997; and Scott Eckert, Hubbs-Sea World research Institute, personal communications, September 26, 1997.

940. Eckert, *op. cit.*, September 26, 1997. Eckert is preparing a soon-to-be-published article assessing the decline of leatherback populations and identifying possible causes.

941. The researchers noted 9 catches/sightings in 1988 and 21 in 1990 from the vessels on which they made observations. The level of incidents correspond somewhat to the seasonality of the swordfish fishery. The researchers provide details on many of these interactions. Jack G. Frazier and José Luis Brito Montero, "Incidental capture of marine turtles by the swordfish fishery at San Antonio, Chile," *Marine Turtle Newsletter*, April, 1990, pp. 8-13. Frazier stressed that their data is now nearly 10 years old. Frazier, *op. cit.*, February 23, 1997. U.S. researchers also report that California shark/swordfish driftnets have also occasionally taken turtles. Hanan, "The California drift gillnet fishery ...," *op. cit.*, p. 26.

942. José Brito-Montero, personal communications, March 3, 1997.

943. Brito, *op. cit.*, March 16, 1997,

944. Mauro González Pino as cited in Frazier and Brito, "Incidental capture ...," *op. cit.*, p. 12.

945. José Brito, "Las tortugas marinas en Chile: Su situación actual," XIV Jornadas de Ciencias del Mar/I Jornada Chilena de la Salmonicultura, May 23-25, 1994, Puerto Montt, Chile.

946. Brito, *op. cit.*, March 16, 1997.

947. Hanan, Holts, and Coan, "The California drift gill net fishery ...," *op. cit.*, p. 26.

948. Pablo Arenas, Instituto Nacional de Pesca (Mexico), personal communications, September 26, 1997.

949. Most of the turtles taken, however, are drowned by the time the nets are retrieved. Brito, *op. cit.*, March 16, 1997.

950. José Luis Brito Montero, "The first sea turtle tagging efforts in Chile," *Marine Turtle Newsletter*, 1995, No. 68, pp. 18-19.

951. Brito, *op. cit.*, March 16, 1997.

952. Bailey, *et. al.*, "By-catch and discards ...," *op. cit.*, table 4.29.

953. "Turtle skins seized," *Fishing News International*, May 1985.

954. Robert A. Dollar, "Annual report of the 1993 Western Pacific longline fishery," *Southwest Fisheries Center Administrative Report* H-94-06, August, 1994, pp. 24-25.

955. W. Nishimura and S. Nakahigashi, "Incidental capture of sea turtles by Japanese research and training vessels; results of a questionnaire," *Marine Turtle Newsletter,* 1990, No. 51, pp. 1-4 and K.L. Eckert, "The biology and population status of marine turtles in the North Pacific Ocean, " *NOAA Technical Memorandum*, 1993, NMFS-SWFSC-186, 156p.

956. For details see Phil Williams, Paul J. Anninos, Pamela T. Plotkin, and Karen L. Salvini, "Pelagic longline fisher-sea turtle interactions," *NOAA Technical Memorandum*, NMFS-OPR-7, February 1996, 77p.

957. Frazier and Brito Montero, "Incidental capture ...," *op. cit.*, p. 12.

958. Yáñez, *op. cit.*, January 22, 1997.

959. Chong, *op. cit.*, December 4, 1996.

960. Azócar, *op. cit.*, January 16, 1997.

961. This is different than the feeding behavior reported by Latin American fishermen in the south Atlantic who report that the whales generally reject sharks. See the Uruguay chapter of this report for details.

962. Silva Martinez, *op. cit.*, December 12, 1996.

963. Salas reported this phenomenon on board the longliner *Brisca.* Salas reports that the captain of another longliner, the *Niño de Corvo,* reported a similar experience. Salas, *op. cit.*, September 1, 1997.

964. See, for example, the Uruguayan chapter of this report.

965. H.L. Schmidt, *op. cit.*, April 8, 1996.

SECTION XVI. (International)

966. Weidner and Jacobson, "Soviet-Latin American fishery relations," *op. cit.*

967. Ley N°600, article 19.

968. For details on Chile's overall experience with foreign fishermen see Weidner and Hall, "Latin America," *op. cit.*, pp. 313-319.

969. Donoso, *op. cit.*, April 11, 1996.

970. Azócar, *op. cit.*, November 15, 1996.; Muñoz Concha, *op. cit.*, November 20, 1996; H.L. Schmidt, *op. cit.*, April 8, 1996; and Wadsworth, *op. cit.*, April 16, 1996.

971. Covarrubias, *op. cit.*, April 1, 1996.

972. For details, see Weidner and Hall, "Latin America," *op. cit.*, pp. 189-192.

973. Covarrubias, *op. cit.*, January 27, 1997. The Chileans when indicating "Chinese" are probably referring to race and not citizenship (Mainland/Taiwan). The vessels are probably Taiwan owned. It is unlikely that Panamanian or Spanish owners would hire all Chinese crews.

974. Wildman, *op. cit.*, January 28, 1997.

975. Covarrubias, *op. cit.*, January 28, 1997.

976. The Japanese have shown great interest in access to Ecuadorean and Peruvian waters. See the individual country chapters for details.

977. An excellent, but now somewhat dated, overview of the Japanese longline fishery in the eastern Pacific is available in Nakano and Bayliff, "A review of the Japanese longline fishery ...," *op. cit.*

978. Japan has a directed swordfish fishery, but it is mostly conducted in Japanese coastal waters and constitutes about half of the country's overall catch of Pacific swordfish. Uozumi, *op. cit.*, February 6, 1997. For details on the Japanese fishery see Wildman, "Asia," Vol. III, *op. cit.*

979. Burgos, *op. cit.*, January 27, 1997.

980. Covarrubias, *op. cit.*, April 1, 1996.

981. Burgos, *op. cit.*, January 27, 1997.

982. NFRDA, "Fishery statistics ...," *op. cit.*

983. Covarrubias, *op. cit.*, April 1, 1996.

984. Panamanian officials have been reluctant to supply information on these vessels. For details, see Weidner and Hall, "Latin America, *op. cit.*, pp. 233-235.

985. Covarrubias, *op. cit.*, January 28, 1997.

986. TRC, *Annual Catch Statistics*, *op. cit.*

987. The vessels in trips during mid-1997 were reporting the best catches off southern Peru close to the Chilean border (Peru, appendix B8a1-2). Salas, *op. cit.*, September 1, 1997. See the Peruvian chapter of this report for details.

988. For details see the Peruvian chapter of this report.

989. Covarrubias, *op. cit.*, August 18, 1995.

990. Donoso, *op. cit.*, April 11, 1996.

991. Burgos, *op. cit.*, January 27, 1997.

992. "Prosiguen las protestas ...," *op. cit.*, p. 35. For details see "Transshipments."

993. "Los armadores ...," *op. cit.*, p. 31.

994. The authors have received varying reports on the number of Spanish vessels active in the ETP. One Chilean company reports that 10-25 Spanish vessels are active. H.L. Schmidt, *op. cit.*, April 8, 1996. The authors, however, have been able to identify only a small number of Spanish vessels active in the swordfish fishery during 1996. The vessels operate out of Ilo and other Peruvian ports. For details see the Peruvian chapter of this report.

995. José Echandía Zegarra, General Manager, TRAMARSA, personal communications, June 21, 1996.

996. See the Peruvian chapter for more detailed information on the Spanish operations. Some Latin American countries such as Peru and Uruguay allow the foreign fishermen to transship because of the substantial income derived from the port calls.

997. Echandía Zegarra, *op. cit.*, June 21, 1996.

998. Burgos, *op. cit.*, January 27, 1997.

999. Covarrubias, *op. cit.*, January 28, 1997.

1000. TRC, *Annual Catch Statistics*, *op. cit.*

1001. See the U.S. chapter of this report for details.

1002. "Growing fresh and frozen catch: 1,000 boats on swordfish," *Fishing News International*, April, 1992, p. 31.

1003. The owner operated the *Mandy J* and *Sundance*. He reportedly would have preferred to use Arica or other Chilean ports because of the more stable political climate, absence of terrorism, and superior port and supply facilities as well as being closer to the fishing grounds. U.S. Embassy reports indicate that he was using the Peruvian port of Callao for the transshipping. U.S. Embassy, Santiago, "Sundance returns," message number 4017, May 22, 1992; U.S. Embassy, Santiago, "USA, Sundance update," message number 5140, July 2, 1992; and U.S. Embassy, Santiago, "Sundance update," message number 5601, July 17, 1992; .

1004. John Childers and Forrest R. Miller, "Summary of the 1994 U.S. north and south Pacific albacore troll fisheries," *Southwest Fisheries Science Center Administrative Report*, LJ-95-15, July 1995, 57p.

1005. For details on the Soviet fishery see Weidner and Hall, "Latin America," *op. cit.*

1006. For details see the Peruvian chapter of this report.

1007. Efforts to obtain information from Russian fishery officials on their operations off Peru and Chile proved unsuccessful. Milan Kravanja, NMFS, personal communications, December 15, 1996.

1008. Wlodzimierz Kaczynski, Research Associate Professor, Institute for Marine Studies, College of Ocean and Fishery Sciences, University of Washington, personal communications, July 9, 1997.

1009. See the Uruguayan chapter of this report for details. Uruguayan fishery officials have criticized the access provided the foreign fishing vessels. The income generated by the fleet activity, however, has convinced other elements of the government to continue the policy of allowing the fishermen to use the port. Olga Mora, INAPE, personal communications, April 15, 1996.

1010. See for example, Hinton and Deriso, "Structure and assessment ...," *op. cit.*

1011. Many industry observers were erroneously convinced that the Treaty would enable foreign fishermen to gain access to Chilean waters or require foreign-imposed minimum catch sized for Chilean fishermen. Canihuante, "Fisheries-Chile: Problems with new treaty," *op. cit.*

1012. "Keep foreign fleets out--to preserve stocks," *Fishing News International*, September, 1996.

1013. Donoso, *op. cit.*, April 11, 1996.

1014. See for example "Nuevo buque para pez espada y mero," *Chile Pesquero*, July-August, 1989, pp. 10-11.

1015. Reyes, "Pesquería y mercado ...," *op. cit.*, p. 31.

1016. Manning, "Summary of investigations ...," *op. cit.*

1017. Ruz, *op. cit.*, December 11, 1995.

1018. For an overview of Japanese involvement in Chilean fisheries see Weidner and Hall, "Latin America," *op. cit.*, pp. 316 and 320-321.

1019. Suisan Sha, *Suisan Nemkan* (Tokyo: Suisan Sha, 1992), pp. 194-195.

1020. Pescanova's Uruguayan subsidiary is Belnova. For details see the Uruguayan chapter of this study.

1021. The Spanish companies associated with these companies are SA Eduardo Vieira (CONCAR), Pesquera Morabal (Pesquera Iberchile), and Grupo Amador Suárez (Pesquera Suribérica).

SECTION XVII. (Enforcement)

1022. See the Peruvian chapter of this report for details.

1023. Weidner and Jacobson. "Soviet-Latin American fishery relations," *op. cit.*

1024. "Chilean factory ship," *The Review of the River Plate*, October 10, 1980, p. 535.

1025. "Los productos descomisados al 'Miño'," *Industrias Pesqueras*, May 15, 1981.

1026. "Liberación del pesquero chileano *Miño*," Chile Pesquero, March, 1981, p. 38.

1027. "Japanese fishing ships held," DYN (Buenos Aires) 245 GMT, March 17, 1989.

1028. "Patrol captures two Peruvian fishing boats, AFP, 1602 GMT, September 8, 1979; "6 Peruvian fishing vessels captured," AFP, 2056 GMT, July 13, 1984; "Otros tres pesqueros peruanos retenidos," *El Mercurio*, August 2, 1984; "Government fines Peruvian fishing boats," Santiago Domestic Service, 1100 GMT, August 31, 1984.

1029. *El Comercio*, September 15, 1978.

1030. For background information see Weidner and Jacobson. "Soviet-Latin American fishery relations," *op. cit.*

1031. "Navy fires on Soviet trawler in marine zone," EFE (Madrid), 0056 GMT, July 15, 1990.

1032. "Protest sent to Soviet Union on fishing incident," Radio Chileana Network (Santiago), 1700 GMT, July 16, 1990.

1033. "Chilean fishermen jailed in Falkland Islands," *World Fishing*, March 1996.

1034. "Court denies jurisdiction in Norwegian ship case," Santiago Radio Cooperativa Network, 1800 GMT, April 23, 1990 and "Accidente del PAM 'Hayduk'", *Chile Pesquero*, June-July, 1995, p. 4.

1035. A VMS system, however, was implemented in 1996 for foreign vessels desiring to transship through Chilean ports. Covarrubias, *op. cit.*, January 27 and September 17, 1997.

APPENDICES

Series A: Vessels
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SERIES A APPENDICES: VESSELS

A1: Overall fishing fleet
A2: Overall swordfish fleet
A3: Commercial/longline swordfish fleet
A4: Artisanal swordfish fleet
A5: Shipyards

Appendix A1a.--Chile. Fishing fleet, 1993-95

Year	Commercial							Artisanal	Total
	Seiners	Trawlers	Longliners	Driftnet	Traps	Harppon	Total		
				Number					
1992	NA	NA	NA	NA	NA	NA	NA	NA	NA
1993	410	72	115	40	2	1	640	8,904	9,544
1994	383	72	88	32	3	-	578	10,864	11,442
1995	370	70	74	28	3	-	545	12,045	12,590
1996	385*	73**	45***	19****	2	-	524#	12,619*****	13,143

NA - Not available
* Nearly 75 percent are registered in Regions I and VIII.
** Over 65 percent are registered in Regions V and VIII.
*** Two thirds are registered in Regions VII and X, primarily targetting groundfish.
**** Two thirds are registered in Region V.
***** Over one-third of the artisanal vessels are rehistered in Region X.
# 207 companies and individuals registered commercial fishing vessels in 1996.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix A1b.--Chile. Active commercial fishing fleet, 1983-96

Year	Vessel		Fleet deployment*	
	Hold capacity	Size	Hold capacity	Size
	$1,000m^3$	1,000 GRT	Percent	
1993	185.5	161.2	NA	NA
1994	187.8	166.7	92	92
1995	178.8	149.3	75	75
1996	195.7	170.2	91	87

* Proportion of the vessels from the Registri Industrial actually deployed.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix A2a.--Chile. Longliners and driftnet vessels, 1993-95

Year	Vessel		Total
	Longline*	Driftnet	
	Number		
1992	NA	NA	NA
1993	115	40	155
1994	88	32	120
1995	74	28	102
1996	45	19	64

* Most of the Chilean longliners target groundfish rather than swordfish. See appendix A3d and A3e1-2 for an estimate and list of the dedicated swordfish longliners.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years

Appendix A2b1.--Chile. Swordfish vessels, 1986-93

Year	Vessels		Total
	Artisanal	Commercial*	
	Number		
1986	NA	NA	25
1987	NA	NA	295
1988	NA	NA	440
1989	NA	NA	450
1990	NA	NA	480
1991	NA	NA	490
1992	NA	NA	470
1993	NA	NA	330

Note: The authors are unable to explain the discrepancies between the various fleet data sets.
NA - Not available
* Reported as "industrial" in Chilean sources.
Note: Data enrtries estimated visually from a graphic.
Source: Ponce and Bustos and IFOP as cited in IFOP, "Estado de situación y perspectivas del recurso," *Pesquerias Nacionales Demersales* (PECES), Zona Centro Sur, 1993, (Santiago: IFOP, April, 1994), p. 59.

Appendix A2b2.--Chile. Swordfish vessels, 1985-96

Year	Vessels		Total
	Artisanal*	Commercial**	
	Number		
1985	NA	NA	1
1986	NA	NA	5
1987	NA	NA	52
1988	NA	NA	58
1989	MA	NA	81
1990	NA	NA	82
1991	NA	NA	184
1992*	NA	NA	259
1993	131	143	274
1994	76	79	155
1995	36	57	93
1996	31	86	117

Note: Includes all vessels reporting a swordfish catch, regardless of the quantity or target species. Discrepancies with other reports are unexplained. Catches in waters beyond the 200-mile limit are not required to be reported to SERNAP. The data was obtained, however, from processing companies. SERNAP reports that most of the swordfish catch taken beyond 200-miles is landed primarily at San Antonia and Coquimbo, especially Coquimbo. Catches beyonf 200-miles are rare in Chile and thus there is loop hole in reporting requirements. SERNAP officials plan to modifying reporting requirements to close this loop hole.
NA - Not available
* SERNAP initiated a register for artisanal vessels in 1992. The vessels are primarily driftnet ("enmalle"), but there are also a few artisanal vessels deploying longlines.
** Reported as "industrial" in Chilean sources.
Source: Departamento de Estadísticas, SERNAP, unpublished data, September 26, 1997.

Appendix A2b3.--Chile. Swordfish vessels, 1986-95

Year	Vessels		Total
	Artisanal	Commercial*	
	Number		
1986	20	NA	NA
1987	295	NA	NA
1988	440	NA	NA
1989	505	NA	NA
1990	510	NA	NA
1991	485	20E	505
1992	450	NA	NA
1993	350	NA	NA
1994	285	NA	NA
1995	286	NA	NA

Note: The authors are unable to explain the discrepancies between the various fleet data sets.
E - estimate
NA - Not available
* Reported as "industrial" in Chilean sources.
Note: Data enrtries estimated visually from a graphic.
Source: M. A. Barbieri, M. Donoso, A. Gonzalez, V. Correa, B. Leiva, and A. Montiel, "Development and state of art of the swordfish fishery in Chile", paper delivered at the International Symposium on Pacific Swordfish, Ensenada, B.C., Mexico, December 11-14, 1994, pp. 2-3 and figure 3 and Miguel Donoso, IFOP, personal communications, September 10, 1997.

Appendix A2c1.--Chile. Vessels in central ports targeting swordfish, 1992-93

Port	Season*	Month								Total
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
		Number of vessels								
San Antonio	1992	22	57	83	171	139	113	74	6	247
	1993	-	43	97	135	127	116	34	-	206
Lebu	1992	6	48	70	43	43	2	-	-	77
	1993	24	75	62	58	37	22	2	-	95
Valdivia	1992	2	20	11	3	-	-	-	-	26
	1993	-	19	9	3	-	-	-	-	20
Totals	1992	30	125	164	217	182	115	74	6	350
	1993	24	137	168	194	164	138	36	-	321

Source: IFOP, "Estado de situación y perspectivas del recurso," *Pesquerias Nacionales Demersales* (PECES), Zona Centro Sur, 1993, (Santiago: IFP, April, 1994), table 4.

Appendix A2c2.--Chile. Number of vessels participating in the swordfish fishery, by port and month, 1992

Port	Vessels											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Number											
Arica	-	1	2	1	2	1	1	1	1			
Caldera	-	1	5	21	27	12	29	13	3			
Coquimbo	-	1	2	2	4	3	186	10	14			
Valparaíso	-	-	-	8	25	47	27	10	-			
San Antonio	-	22	57	83	171	139	113	74	6			
Constitución	1	3	28	41	30	18	11	2	4			
San Vicente	-	2	27	50	56	52	13	-	-			
Lebu	-	6	48	70	43	43	2	-	-			

Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesqueria de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993, p. 33.

Appendix A2d1.--Chile. Number of vessels participating in the swordfish fishery, by port and month, 1994

Fleet/ port	Vessels											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Number											
Artisanal												
Caldera						4	2	3	-	-	-	-
Coquimbo						-	3	35	-	-	-	-
Valparaíso						59	51	48	29	-	-	-
San Antonio						59	71	27	-	-	-	-
Constitución						9	14	3	-	-	-	-
Talcahuano						9	2	4	1	-	-	-
Lebu						39	35	-	-	-	-	-
Total						179	178	120	30	-	-	-
Commercial												
Coquimbo						9	10	14	10	9	6	7

Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones, 1994,)" Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 38.

Appendix A2d2.--Chile. Number of vessels participating in the swordfish fishery, by port and month, 1995

Fleet/ port	Vessels											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Number											
Artisanal												
Caldera	-	-	29	58	35	42	-					
Coquimbo	-	-	-	-	5	17	56					
Valparaíso	-	2	13	19	14	14	5					
San Antonio	-	-	14	39	48	49	7					
Constitución	-	2	9	14	8	7	5					
Talcahuano	-	-	-	-	4	10	4					
Lebu	-	14	59	64	45	38	-					
Total	-	18	124	194	159	177	77					
Commercial												
Coquimbo	3	2	6	4	5	6	3					

Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones, 1994,)" Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 38.

Appendix A2e.--Chile. Characteristics of the swordfish fleet, 1991

Entry	Fleet	
	Vessels	Proportion
	Number	Percent
Port		
San Antonio	191	
Caldera	78	
Constitución	68	
Valparaíso	67	
Lebu	65	
San Vicente	42	
Valdivia	6	
Subtotal	517	
Length*		
Less than 9 meters	5	
9.1-18.0 meters	420	
18.1-28.0 meters	20	
More than 28 meters	10	
Subtotal	455	
Size*		
Less than 10 GRT		6
10-15 GRT		6
15.1-20.0 GRT		17
20.1-25.0 GRT		23
25.1-30.0 GRT		17
30.1-35.0 GRT		11
35.1-40.0 GRT		8
40.1-45.0 GRT		4
Over 45 GRT		6
Unknown		3
Subtotal		100**
Horsepower*		
Under 41 HP	9	
41.0-80.9 HP	23	
81.0-120.9 HP	94	
121.0-160.9 HP	133	
161.0-200.9 HP	84	
201.0-240.9 HP	28	
241.0-280.9 HP	7	
281.0-320.9 HP	13	
More than 321 HP	8	
Unknown	46	
	445	

* Entries estimated visually from graphic
** Totals may not agree due to rounding
Note: It is unclear why the number of vessels in each entry vary so markedly. Minor differences may be due to the difficulties of estimating numerical values from graphics. The major differences, however, suggest that some of the enrties are from different, less complete data sets.
Source: José Donoso P. and Carlos Montenegro, "Inves. monitoreo pesqueria de albacora temporada 1991," (IFOP Nº inven: 920020), October 1992, pp. 10-13.

Appendix A2f.--Chile. Swordfish fleet, 1990-91

Vessel type/ length	Vessels	
	Number	Proportion
Met Meters		Number Percent
Artisanal vessels		
Bongas (<9 m)		
<7	5	Negl
7-9	58	5
Subtotal	63	5
Lanchas (9-18 m)		
9-12	221	18
12-18	754	63
Subtotal	975	81
Total, artisanal	1,038	86
Commercial vessels		
Medium (18-28 m)		
18-22	62	5
22-26	14	1
26-28	2	Negl
Subtotal	78	6
Large (>28 m)		
28-31	9	1
33-40	12	1
40-48	8	1
48-63	8	1
63-67	2	Negl
67-70	7	1
70-73	3	Negl
92	1	Negl
Subtotal	50	4
Total, commercial	128	11
Other*	40	3
Total	1,206	100

* Not data available

Source: Francisco Ponce Martínez and René Bustos, "La pesquería de pez espada *Xiphias gladius* Linnaeus, 1758 en Chile," *Revista Pacifífico Sur*, No. 19, 1991, p. 28.

Appendix A3a.--Chile. Longline fleet, 1994

Vessel	Type	Built		Owner	Hull	Size		
		Country	Year			Vessel	Hold	Length
						GRT	Cu. Met	Meters
Longline								
Antonio Lorenzo	Freezer	Spain	1960	CONCAR	Steel	499	500	46.8
Areamilla	Tuna	Spain	1962	Pesquera Santa Ana	Steel	237	263	28.2
Betty	Ice boat			Pesquera Omega				18.0
(El) Brisca	Ice boat	Spain	1960	Pesquera Santa Ana	Steel	263	280	28.2
Canadelo	Highseas	Spain	1963	Pesquera Santa Ana	Steel	239	263	28.2
Cisne Blanco	Freezer*	Spain	1976	Pesca Cisne	NA	537	571	45.6
Cisne Verde	Freezer*	Spain	1976	Pesca Cisne	NA	531	556	45.2
Curaco I	Ice boat*	Spain	1989	Empresa del Estrecho	PVRF	289	230	26.6
Chaval	Freezer	Spain	1977	Pesquera Punta Arenas	Steel	402	184	37.6
Chomapi Maru	Freezer	Spain	1965	Pesca Chile	Steel	465	350	41.0
Elqui	Freezer	Spain	1966	Pesquera de los Andes	Steel	507	400	40.8
Friosur III	Ice boat	Japan	1971	Pesquera Friosur	Steel	466	384	45.1
Friosur V	Freezer**	Japan	NA	Frioaysen	Steel	795	747	51.8
Iber I	Freezer	Spain	1982	Pesquera Iber Chile	Steel	485	433	38.0
Isabel				Pesquera Omega				
Isla Camilla	Freezer	Neth.	1972	Pesquera Sudiberica	Steel	653	456	48.5
Isla de Pascua	Tuna	Spain	1990	Emp. Pesquera Ficossa	Steel	156	139	25.1
Isla Guafo	Ice boat	Japan	1974	Actividades Integradas	Steel	481	450	46.4
Isla Guamblin	Ice boat	Japan	1973	Actividades Integradas	Steel	375	355	42.5
Isla Isabel	Freezer	Norway	1974	Pesca Sudiberica	Steel	486	367	37.2
Isla Nueva	Tuna	Brazil	1976	Soc. Punta del Este	Steel	80	272	20.0
Isla Picton	Tuna	Brazil	1976	Comtesa	Steel	80	272	20.0
Isla Sofia	Freezer	Neth.	1972	Pesca Suribérica	Steel	653	456	48.5
Jacaf	Ice boat	Spain	1988	Pesca Chile	Poliester	292	72	26.6
Kofuku Maru 58	Ice boat	Japan	1964	Empacadora Montemar	Steel	97	115	27.0
Lucia	Tuna***	Neth	1967	Pesquera Santa Lucía	Steel	196	103	26.4
Magallanes III	Ice boat	Japan	1969	Pesca Chile	Steel	536	370	48.6
Mar del Sur I	Freezer	Japan	1972	Pesquera Mar del Sur	Steel	690	491	48.0
Mar del Sur II	Freezer	Italy	1966	Pesquera Mar del Sur	Steel	744	400	55.2
Mar del Sur III	Freezer	Japan	1969	Pesquera Mar del Sur	Steel	411	556	52.4
Mar Azul X	Ice boat	Japan	1977	Pesquera Marazul	Steel	715	400	46.0
Mar Azul XII	Ice boat	Japan	1980	Pesquera Marazul	Steel	527	352	42.3
Mar Azul XIV	Ice boat	Japan	1973	Pesquera Marazul	Steel	551	347	42.8
Mar Azul XV	Ice boat	Japan	1980	Pesquera Marazul	Steel	616	371	43.1
Maria Tamara	Freezer	Germany	1967	CONCAR	Steel	497	600	52.2
(Las) Nieves###								
Niño de Corvo	Ice boat#	Spain	1972	Pesquera Calcurrupe	Steel	262	180	30.1
Olimpo	Comb##	Chile	1978	C.P.N. Pro Austral	Wood	88	80	22.0
Pacific Seas###								
Pedrosa	Freezer	Spain	1965	Pesca Chile	Steel	504	350	40.8
Pesca Chile Dos	Ice boat	Chile	1988	Pesca Chile	Steel	79	70	18.0
Pesca Chile Cuatro	Ice boat	Chile	1989	Pesca Chile	Steel	79	70	18.0
Portugal II	Ice boat			Pesquera Omega				26.0
Puerto Ballena	Freezer	Spain	1986	Pesca Chile	Steel	753	550	53.4
Puerto Natales 1	Ice boat	Spain	1958	Pes. Puerto Natales	Steel	216	150	30.2

Puerto Natales 2	Ice boat	U.K.	1969	Pes. Puerto Natales	Steel	239	160	28.5
Puyuguapi	Ice boat	Spain	1988	Pesca Chile	Poly Ref	292	240	26.6
Talcan	Ice boat*	Spain	1989	Empresa del Estrecho	Steel	289	230	26.6
Tami-S+++	Freezer	Japan	1980	Pesquera Omega	Steel	299		48.0
Torres del Paine	Freezer	Spain	1986	Pesquera del Sur	Steel	275	180	31.5
Thamapu	Ice boat	Spain	1988	Pesca Chile	Poliéster+	292	240	26.6

Gillnet
List of vessels unavailable++

Unknown
Vamas II Pesquera Santa Lucía

Note: Additional information on these vessels, including assigned radio signals, shipyard built, original owner, earlier names, registration number, NRT, FO capacity, motor type and size, number of propellers, width, and draft are available in the source indicated below.
* Espinelero. This also means longline in Spanish. The authors are not sure as to how this differs from palangero.
** The source uses both "factoria" and "fabrica", both mean factory in Spanish. This vessel is identified as "fábrica" rather than a "factoria". The authors believe that "factoria" means freezer vessels, but are unsure as to the precise meaning of "fabrica", although "fábrica" appears to be a larger vessels with the capability for more than just freezing.
*** Enmalle. This means driftnet in Spanish. Presumbably this is a combination vessel also capable of driftnet operations.
**** One 1997 report indicates that these boats were being operated by Apóstol Santiago.
# Trampa. This means trap in Spanish. Presumbably this is a combination vessel also capable of trap operations.
Combination vessel: longliner, trawler, espinelero
Longliners cooperating with IFOP research during 1994-95
+ And fiberglass
++ The source lists "Various other fishing boats", but does not detail which are gillnet vessels.
+++ Often deployed in the Atlantic out of Montevideo
Source: Ricardo Cortés D., Director, EDITEC, *Catálogo Tecnico de Buques Pesqueros y Remolcadores de Alta Mar* (EDITEC: Santiago, 1994), pp.156-167.

Appendix A3b.--Chile. Companies operating longliners, 1994

Company/ Vessel	Type	Built Country	Built Year	Hull	Size Vessel GRT	Size Hold Cu. Met	Size Length Meters	Target species###
Actividades Integradas								
Isla Guafo+++	Ice boat	Japan	1974	Steel	481	450	46.4	
Isla Guamblin+++	Ice boat	Japan	1973	Steel	375	355	42.5	
Cia. Pesquera y Nav. Pro Austral								
Olimpo	Comb##	Chile	1978	Wood	88	80	22.0	
Comtesa								
Isla Picton++++	Tuna	Brazil	1976	Steel	80	272	20.0	
Construciones y Carpintería Naval (CONCAR)								
Antonio Lorenzo	Freezer	Spain	1960	Steel	499	500	46.8	
Maria Tamara	Freezer	Germany	1967	Steel	497	600	52.2	
Empresa del Estrecho								
Curaco I	Ice boat*	Spain	1989	PVRF	289	230	26.6	Swordfish (1996)
Talcan	Ice boat*	Spain	1989	Steel	289	230	26.6	Swordfish (1996)
Empresa Pesquera Ficossa								
Isla de Pascua	Tuna	Spain	1990	Steel	156	139	25.1	
Frioaysen								
Friosur V	Factory**	Japan	NA	Steel	795	747	51.8	
Pesca Chile								
Chomapi Maru	Freezer	Spain	1965	Steel	465	350	41.0	
Jacaf	Ice boat	Spain	1988	Poliester	292	72	26.6	
Lerez####								
Magallanes III	Ice boat	Japan	1969	Steel	536	370	48.6	
Pedrosa	Freezer	Spain	1965	Steel	504	350	40.8	
Pesca Chile####								
Pesca Chile Dos	Ice boat	Chile	1988	Steel	79	70	18.0	
Pesca Chile Cuatro	Ice boat	Chile	1989	Steel	79	70	18.0	
Puerto Ballena	Freezer	Spain	1986	Steel	753	550	53.4	
Puyuguapi	Ice boat	Spain	1988	Poly Ref	292	240	26.6	
Thamapu	Ice boat	Spain	1988	Poliéster+	292	240	26.6	
Pesca Cisne								
Cisne Blanco	Freezer*	Spain	1976	NA	537	571	45.6	Groundfish
Cisne Verde	Freezer*	Spain	1976	NA	531	556	45.2	Groundfish
Pesca Suribérica								
Isla Camilla	Freezer	Neth.	1972	Steel	653	456	48.5	
Isla Isabel	Freezer	Norway	1974	Steel	486	367	37.2	
Isla Sofia	Freezer	Neth.	1972	Steel	653	456	48.5	
Pesquera Apostol Santiago@@@@								
Pesquera Calcurrupe								
Niño de Corvo	Ice boat#	Spain	1972	Steel	262	180	30.1	Swordfish (1996)
Pesquera de los Andes								
Elqui	Freezer	Spain	1966	Steel	507	400	40.8	
Pesquera del Sur								
Torres del Paine@	Freezer	Spain	1986	Steel	275	180	31.5	
Pesquera Esolmar								
Torres de Paine@	Freezer	Spain	1986	Steel	275	180	31.5	
Pesquera Friosur								
Friosur III	Ice boat	Japan	1971	Steel	466	384	45.1	

Pesquera Iber Chile								
Iber I	Freezer	Spain	1982	Steel	485	433	38.0	
Pesquera Isla del Rey								
Unknown								Groundfish
Pesquera Mar del Sur								
Mar del Sur I	Freezer	Japan	1972	Steel	690	491	48.0	Groundfish
Mar del Sur II	Freezer	Italy	1966	Steel	744	400	55.2	Groundfish
Mar del Sur III	Freezer	Japan	1969	Steel	411	556	52.4	Groundfish
Pesquera Marazul								
Mar Azul X	Ice boat	Japan	1977	Steel	715	400	46.0	
Mar Azul XII	Ice boat	Japan	1980	Steel	527	352	42.3	
Mar Azul XIV	Ice boat	Japan	1973	Steel	551	347	42.8	
Mar Azul XV	Ice boat	Japan	1980	Steel	616	371	43.1	
Pesquera Montemar								
Kofuku Maru 58	Ice boat	Japan	1964	Steel	97	115	27.0	Swordfish (1996)
Pesquera Omega								
Betty K	Ice boat						18.0	Swordfish (1996)
Isabel S								Swordfish (1996)
Portugal II	Ice boat						26.0	Swordfish (1996)
Tami-S****	Freezer						48.0	Swordfish (1996)
Pes. Puerto Natales								
Puerto Natales 1	Ice boat	Spain	1958	Steel	216	150	30.2	
Puerto Natales 2	Ice boat	U.K.	1969	Steel	239	160	28.5	
Pesquera Punta Areneas								
Chaval	Freezer	Spain	1977	Steel	402	184	37.6	
Pesquera Santa Ana								
Areamilla	Tuna	Spain	1962	Steel	237	263	28.2	
Brisca	Ice boat	Spain	1960	Steel	263	280	28.2	
Canadelo	Highseas	Spain	1963	Steel	239	263	28.2	
Pesquera Santa Lucía*****								
Lucia	Tuna***	Neth	1967	Steel	196	103	26.4	Swordfish
Vamas II								Swordfish
Soc. Punta del Este								
Isla Nueva	Tuna	Brazil	1976	Steel	80	272	20.0	
SOPESCA-ALIMAR+++++								
Brisca (See Pesquera Santa Ana)								
Unknown								
(Las) Nieves@@@								Swordfish
Pacific Seas@@@								Swordfish
Vamas								

Note: Additional information on these vessels, including assigned radio signals, shipyard built, original owner, earlier names, registration number, NRT, FO capacity, motor type and size, number of propellers, width, and draft are available in source.
Addresses: The available addresses and telephone numbers of these companies are listed in appendix I.
* Espinelero. This also means longline in Spanish. The authors are not sure as to how this differs from palangero.
** The source uses both "factoria" and "fabrica", both mean factory in Spanish. This vessel is identified as "fábrica" rather than a "factoria". The authors believe that "factoria" means freezer vessels, but are unsure as to the precise meaning of "fabrica". It appears to mean a larger vessels with the capability for more than just freezing.
*** Enmalle. This means driftnet in Spanish. Presumbably this is a combination vessel also capable of driftnet operations.
**** Often deployed in the Atlantic out of Montevideo
***** Ceased operations September 1995
# Trampa. This means trap in Spanish. Presumbably this is a combination vessel also capable of trap operations.
Combination vessel: longliner, trawler, espinelero
Vessels actually operating in 1996 for at least part of the year
Transferred to the Pescanova Uruguyan afiliate, Belnova.

Spanish company which one observers indicated operates longliners. The authors, however, cannot identify the vessels involved.
+ And fiberglass
++ The source lists "Various other fishing boats", but does not detail which are gillnet vessels.
+++ Acquired from Pesquera Guafo
++++ Originally owned by Empresa Pesquera Tarapacá
+++++ It is unclear which company (Pesquera Santa Ana or SOPESCA-ALIMAR) owns El Brisca
@ It is unclear which company owns this vessel.
@@ The company reports it deploys longliners for Patagonian toothfish, but the names of the vessels are unavilable.
@@@ These two vessels cooperated in IFOP research work, but the authors have no listings indicating which companies
operated the vessels. A Sr. Montalveti owned the *Pacific Seas*.
@@@@ This company was reportedly operating the *El Brisca* and *Kofuku Maru* in 1996-97.
Source: Ricardo Cortés D., Director, EDITEC, *Catálogo Tecnico de Buques Pesqueros y Remolcadores de Alta Mar* (EDITEC: Santiago, 1994), pp.156-167 and various other sources.

Appendix A3c.--Chile. Longline fleet by country of construction, 1994

Country/ vessel	Type	Built	Age+++	Owner	Hull	Size		
						Vessel	Hold	Length
			Years			GRT	Cu. Met	Meters
Brazil (2 vessels)								
Isla Nueva	Tuna	1976	18	Soc. Punta del Este	Steel	80	272	20.0
Isla Picton	Tuna	1976	18	Comtesa	Steel	80	272	20.0
Average			18			80	272	20.0
Chile (3 vessels)								
Olimpo	Comb##	1978	16	C.P.N. Pro Austral##	Wood	88	80	22.0
Pesca Chile Dos	Ice boat	1988	6	Pesca Chile##	Steel	79	70	18.0
Pesca Chile Cuatro	Ice boat	1989	5	Pesca Chile##	Steel	79	70	18.0
Average			9			82	73	19.3
Germany (1 vessel)								
Maria Tamara	Freezer	1967	27	CONCAR##	Steel	497	600	52.2
Italy (1 vessel)								
Mar del Sur II	Freezer	1966	28	Pesquera Mar del Sur	Steel	744	400	55.2
Japan (13 vessels)								
Friosur III	Ice boat	1971	23	Pesquera Friosur##	Steel	466	384	45.1
Friosur V	Freezer**	NA		Frioaysen	Steel	795	747	51.8
Isla Guafo	Ice boat	1974	20	Actividades Integradas	Steel	481	450	46.4
Isla Guamblin	Ice boat	1973	21	Actividades Integradas	Steel	375	355	42.5
Kofuku Maru 58	Ice boat	1964	30	Empacadora Montemar	Steel	97	115	27.0
Magallanes III	Ice boat	1969	25	Pesca Chile##	Steel	536	370	48.6
Mar del Sur I	Freezer	1972	22	Pesquera Mar del Sur##	Steel	690	491	48.0
Mar del Sur III	Freezer	1969	25	Pesquera Mar del Sur##	Steel	411	556	52.4
Mar Azul X	Ice boat	1977	17	Pesquera Marazul##	Steel	715	400	46.0
Mar Azul XII	Ice boat	1980	14	Pesquera Marazul##	Steel	527	352	42.3
Mar Azul XIV	Ice boat	1973	21	Pesquera Marazul##	Steel	551	347	42.8
Mar Azul XV	Ice boat	1980	14	Pesquera Marazul##	Steel	616	371	43.1
Tami-S++	Freezer	1980	14	Pesquera Omega	Steel	299		48.0
Average			21			505	412	44.9
Netherlands (3 vessels)								
Isla Camilla	Freezer	1972	22	Pesca Suribérica##	Steel	653	456	48.5
Isla Sofia	Freezer	1972	22	Pesca Suribérica##	Steel	653	456	48.5
Lucia	Tuna***	1967	27	Pesquera Santa Lucía##	Steel	196	103	26.4
Average			24			501	338	41.1
Norway (1 vessel)								
Isla Isabel	Freezer	1974	20	Pesca Suribérica##	Steel	486	367	37.2
Spain (21 vessels)								
Antonio Lorenzo	Freezer	1960	34	CONCAR##	Steel	499	500	46.8
Areamilla	Tuna	1962	32	Pesquera Santa Ana##	Steel	237	263	28.2
Brisca	Ice boat	1960	34	Pesquera Santa Ana##	Steel	263	280	28.2
Canadelo	Highseas	1963	31	Pesquera Santa Ana##	Steel	239	263	28.2
Cisne Blanco	Freezer*	1976	18	Pesca Cisne##	NA	537	571	45.6
Cisne Verde	Freezer*	1976	18	Pesca Cisne##	NA	531	556	45.2
Curaco I	Ice boat*	1989	5	Pesquera del Estrecho##	PVRF	289	230	26.6
Chaval	Freezer	1977	17	Pesquera Punta Arenas##	Steel	402	184	37.6
Chomapi Maru	Freezer	1965	29	Pesca Chile##	Steel	465	350	41.0
Elqui	Freezer	1966	28	Pesquera de los Andes##	Steel	507	400	40.8
Iber I	Freezer	1982	12	Pesquera Iber Chile##	Steel	485	433	38.0
Isla de Pascua	Tuna	1990	4	Emp. Pesquera Ficossa##	Steel	156	139	25.1
Niño de Corvo	Ice boat#	1972	22	Pesquera Calcurrupe	Steel	262	180	30.1
Pedrosa	Freezer	1965	29	Pesca Chile##	Steel	504	350	40.8
Jacaf	Ice boat	1988	6	Pesca Chile##	Poliester	292	72	26.6

Puerto Ballena	Freezer	1986	6	Pesca Chile##	Steel	753	550	53.4
Puerto Natales 1	Ice boat	1958	36	Pes. Puerto Natales##	Steel	216	150	30.2
Puyuguapi	Ice boat	1988	6	Pesca Chile##	Poly Ref	292	240	26.6
Talcan	Ice boat*	1989	5	Pesquera del Estrecho##	Steel	289	230	26.6
Torres del Paine	Freezer	1986	8	Pesquera del Sur##	Steel	275	180	31.5
Thamapu	Ice boat	1988	8	Pesca Chile##	Poliéster+	292	240	26.6
Average			18			371	320	34.5
United Kingdom (1 vessel)								
Puerto Natales 2	Ice boat	1969	25	Pes. Puerto Natales##	Steel	239	160	28.5
Unknown (3 vessels)								
Betty	Ice boat			Pesquera Omega				18.0
Isabel				Pesquera Omega				
Portugal II	Ice boat			Pesquera Omega				26.0

Note: Additional information on these vessels, including assigned radio signals, shipyard built, original owner, earlier names, registration number, NRT, FO capacity, motor type and size, number of propellers, width, and draft are available in source indicated below.
* Espinelero. This also means longline in Spanish. The authors are not sure as to how this differs from palangero.
** The source uses both "factoria" and "fabrica", both mean factory in Spanish. This vessel is identified as "fábrica" rather than a "factoria". The authors believe that "factoria" means freezer vessels, but are unsure as to the precise meaning of "fabrica", presumably "fábrica". It appears to be larger vessels with the capability
of more than just freezing.
*** Enmalle. This means driftnet in Spanish. Presumbably this is a combination vessel also capable of driftnet operations.
# Trampa. This means trap in Spanish. Presumbably this is a combination vessel also capable of trap operations.
Combination vessel: longliner, trawler, espinelero
Original owner
The name of this vessel suggests a Japanese-built vessel, but the source identifies it as a Spanish-built vessel.
+ And fiberglass
++ Often deployed in the Atlantic out of Montevideo
+++ As of 1994
Source: Ricardo Cortés D., Director, EDITEC, *Catálogo Tecnico de Buques Pesqueros y Remolcadores de Alta Mar* (EDITEC: Santiago, 1994), pp.156-167.

Appendix A3d.--Chile. Commercial longline fleet*, 1993-96

Year	Longliners			Total
	North*	VI-VII**	South**	
		Number		
1992	NA	NA	NA	NA
1993	22	30	63	115
1994	14	24	50	88
1995	9	19	46	74
1996	5	16**	24	45

* The longliners operating in the north (Regions I-V) are believed to be the larger Chilean swordfish longliners, capable of distant-water operations.
** Longliners based in Rgions VI-VII (primarily Constitución) are believed to be deployed in various fisheries, including swordfish. Longliners in 1996, for example, were deployed for swordfish (6) and demersal species, espcially Patagonian toothfish (10). Most of the Constitución longliners are relatively small vessels, less than 18 meters.
*** The longliners operating in the south (Regions VIII-XII) primarily target groundfish.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years and Viviana Gaete Merino, Departamento SIEP/SERNAP, personal communications, October 1, 1997.

Appendix A3e1.--Chile. Commercial swordfish vessels, 1992

Vessel	Length	Size	Motor
	Meters	GRT	HP
Driftnet			
Pacific Sea	21.2	68.4	
Pinguin	30.7	158.0	930
Vama II	26.6	226.1	720
Longline			
Areamilla	28.2		
Brisca	35.6		
Canadelo	30.5		
Kofuku Maru	27.0		
Marazul XI	61,5	621.0	
Marazul XII	61.5	527.0	
Marazul XVI	61.5	691.0	
(Las) Nieves	33.5		
Portugal II	28.2		
Talcan	30.0		
Multiple gear (driftnet and longline)			
Carlos Darwin	29.6	202.9	400
Lucia	29.8	196.0	915

Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesqueria de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993, p. 40.

Appendix A3e2.--Chile. Swordfish longliners, 1996-97

Vessel	Company**	Registration	Length	Size
		Number	Meters	GRT
Ariamilla	Pesquera Santa Ana	2704	28.2	237
Betty July	Pesquea Omeg	3744	15.0	
Betty-K		4411	18.0	50
(El) Brisca	Pesquera Apostol Santiago		28.2	263
Cristina S		2967		
Curaco	Pesquera del Estrecho		26.6	289
Elena S				
Isabel-S	Pesquera Omega	4410	18.0	50
Kofuku Maru	Pesquera Apostol Santiago	2188	27.0	97
Lucia	Pesquera Santa Lucía		26.4	196
Maria Soledad				
(Las) Nieves		4236	33.5	243
Niño do Corvo	Pesquera Calcurrupe	2704	30.1	162
Pacific Seas	Sr. Montalveti***			
Portugal II	Pesquera Omega	2433	28.2	170
Talcan	Pesquera del Estrecho		26.6	292
Torres del Paine*	Pesquera del Sur		31.5	275

* Did not operate in 1986 because of legal problems.
** Some of these vessels are in the process of being sold.
*** Reportedly using American-style fishing techniques.
Source: Miguel Donoso, IFOP, personal communications, December 20, 1996 and appendix A3b.

Appendix A4a.--Chile. Artisanal swordfish vessels, 1986-95

Year	Vessels
	Number
1986	25
1987	295
1988	435
1989	510
1990	515
1991	490
1992	450
1993	350
1994	275
1995	286

Note: Data enrties estimated visually from a graphic.
Source: M. A. Barbieri, M. Donoso, A. Gonzalez, V. Correa, B. Leiva, and A. Montiel, "Development and state of art of the swordfish fishery in Chile", paper delivered at the International Symposium on Pacific Swordfish, Ensenada, B.C., Mexico, December 11-14, 1994, figure 3 (1986-94 data) and Miguel Dononso, IFOP, personal communications, September 10, 1997 (1995 data).

Appendix A4b.--Chile. Artisanal swordfish vessels, average characteristics, 1989-92

Year	Length	Power	Size
	Meters	Horse power	GRT
1989	14.4	143	24.3
1990	14.7	155	25.2
1991	14.8	153	24.8
1992	15.1	158	27.0

Note: Data enrtries estimated visually from a graphic.
Source: M. A. Barbieri, M. Donoso, A. Gonzalez, V. Correa, B. Leiva, and A. Montiel, "Development and state of art of the swordfish fishery in Chile", paper delivered at the International Symposium on Pacific Swordfish, Ensenada, B.C., Mexico, December 11-14, 1994, figure 4.

Appendix A4c.--Chile. Vessel ownership, 1990-91

Region*	Vessel size	Ownership**	
		Vessel	Gear
	Meters	Percent	
I-III	<18	70	70
	18-28	NA	NA
	28>	-	-
V	<18	20	Negl
	18-28	NA	NA
	28>	-	-
VIII	<18	60	50
	18-28	NA	NA
	28>	-	-

* Regions delineated in map 2.
** Owned by operators
Source: Francisco Ponce Martínez and René Bustos, "La pesquería de pez espada *Xiphias gladius* Linnaeus, 1758 en Chile," *Revista Pacifífico Sur*, No. 19, 1991, p. 28.

Appendix A4d.--Chile. Artisanal swordfish vessels, by length, 1992-93

Length	Artisanal fleet	
	Vessels	Proportion
Meters	Number	Percent
8 - 9.9	8	2.1
10 - 11.9	9	2.4
12 - 13.9	34	9.0
14 - 15.9	193	51.4
16 - 17.9	115	30.6
18 - 19.9	17*	4.5
Total	376	100.0

* Three of these vessels are commercial.
Source: M. A. Barbieri, M. Donoso, A. Gonzalez, V. Correa, B. Leiva, and A. Montiel, "Development and state of art of the swordfish fishery in Chile", paper delivered at the International Symposium on Pacific Swordfish, Ensenada, B.C., Mexico, December 11-14, 1994, p. 11.

Appendix A4e.--Chile. Artisanal swordfish vessels, by motor size, 1992

Motors	Artisanal fleet	
	Vessels	Proportion
Horsepower	Number	Percent
21.0-40.9	2	0.8
41.0-60.9	4	1.6
61.0-80.9	6	2.3
81.0-100.9	30	11.6
101.0-120.9	26	10.1
121.0-140.9	17	6.6
141.0-160.9	75	29.1
161.0-180.9	32	12.4
181.0-200.9	25	9.7
201.0-220.9	6	2.3
221.0-240.9	20	7.8
241.0-260.9	3	1.2
261.0-280.9	3	1.2
281.0-300.9	5	1.9
301.0-320.9	3	1.2
>321.0	1	0.4
Total*	258	100.0

* Totals may not agree due to rounding.
Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesqueria de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993, p. 35.

Appendix A4f.--Chile. Artisanal swordfish vessels, by size, 1992

Motors	Artisanal fleet	
	Vessels	Proportion
GRT	Number	Percent
<10.0	8	2.3
10.1-15.0	16	4.6
15.1-20.0	42	12.1
20.1-25.0	89	25.7
25.1-30.0	81	23.3
30.1-35.0	45	13.0
35.1-40.0	35	10.1
40.1-45.0	18	5.2
45.1-50.0	13	3.8
Total*	347	100.0

* Totals may not agree due to rounding.
Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesquería de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993, p. 36.

Appendix A5.--Chile. Shipyards constructing longliners

Shipyard	Location	Year	Vessel	Type	Owner	Hull	Size
							GRT
Carpinteros de Ribera	Puerto Montt	1978	Olimpo	Comb##	C.P.N. Pro Austral	Wood	88
ASMAR	Valparíso	1988	Pesca Chile Dos	Ice boat	Pesca Chile	Steel	79
ASMAR	Valparíso	1989	Pesca Chile Cuatro	Ice boat	Pesca Chile	Steel	79
Marco	San Antonio	1994	NA	NA	NA	NA	NA

Note: The EDITEC catalog does not include every Chilean longliner, but it does include the great bulk of them, clearly indicating only a handful of small longliners have been built domestically.
Source: Ricardo Cortés D., Director, EDITEC, *Catálogo Tecnico de Buques Pesqueros y Remolcadores de Alta Mar* (EDITEC: Santiago, 1994), pp.156-167 and Marco promotional literature.

SERIES B APPENDICES: BIOLGICAL DATA

B1: Sex
B2: Feeding
B3: Sea-surface tempertures
B4: Sea color
B5: Sizes
B6: Year classes
B7: Spawning

Appendix B1a.--Chile. Swordfish catches* by sex, 1989

Year/ month	Longline			Dritnet			Total		
	Male	Female	Fish	Male	Female	Fish	Male	Female	Fish
	Percent		Number	Percent		Number	Percent		Number
1994									
May	41	59	29	-	-	-	41	59	29
June	50	50	22	33	67	12	44	56	34
July	38	62	36	-	-	-	38	62	36
August	41	59	34	-	-	-	41	59	34
September	33	67	9	-	-	-	33	67	9
December	50	50	120	-	-	-	50	50	120
1995									
April	-	-	-	9	91	19	9	91	19
May	60	40	66	17	83	47	44	56	113
June	33	67	39	-	-	-	33	67	39

* Artisanal catches in the central zone.
Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones, 1994,)" Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 63.

Appendix B1b.--Chile. Artisanal swordfish catches* by sex, 1989

Season	Harpoon		Driftnet		Total	
	Male	Female	Male	Female	Male	Female
			Percent			
January-April	15	85	-	100	11	89
May- July	-	-	49	51	49	51

* Artisanal catches in the central zone.
Source: M. A. Barbieri, M. Donoso, A. Gonzalez, V. Correa, B. Leiva, and A. Montiel, "Development and state of art of the swordfish fishery in Chile", paper delivered at the International Symposium on Pacific Swordfish, Ensenada, B.C., Mexico, December 11-14, 1994, p. 11.

Appendix B2a.--Chile. Stomache contents of swordfish,* 1989

Season	Proportion
	Percent
Longtailed hake	62
Jack mackerel	59
Nylon shrimp	9
Other finfish	13
Squid	14

Note: Entries estimated visually from graphic
* Artisanal catches in the central zone.
Source: M. A. Barbieri, M. Donoso, A. Gonzalez, V. Correa, B. Leiva, and A. Montiel, "Development and state of art of the swordfish fishery in Chile", paper delivered at the International Symposium on Pacific Swordfish, Ensenada, B.C., Mexico, December 11-14, 1994, figure 10.

Appendix B2b.--Chile. Seasonal landing pattern of swordfish and prey species, 1995

Species	Vessels												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	1,000 Metric tons												
Swordfish	Negl	Negl	0.1	0.4	0.5	0.5	0.3	0.3	0.2	0.1	0.1	Negl	2.6
Jack mackerel	334.1	349.0	441.2	576.2	665.6	595.8	636.6	390.3	83.6	45.9	42.5	243.5	4,404.2
Longtailed hake	4.4	10.4	0.6	1.3	5.2	2.4	2.7	1.2	21.2	86.2	28.5	42.8	206.7

Note: The 1995 jack mackerel catch is probably a better indicator of the seasonal distribution than catches during the 1980s as the Chilean fleet expanded during the early 1990s and now takes the species over a much greater portion of the species' range.
Source: SERNAP, *Anuario Estadístico de Pesca*, 1995.

Appendix B2c.--Chile. Regional landing pattern of swordfish and prey species, 1995

Year	Region*												Total
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	IW	
	1,000 Metric tons													
Swordfish	-	Negl	0.1	0.2	1.6	-	0.1	0.3	-	Negl	-	-	0.3	2.6
Jack mackerel	157.2	72.9	40.2	44.6	884.8	-	Negl	3,204.0	-	0.4	-	-	-	4,404.2
Longtailed hake	-	-	-	-	Negl	-	-	192.2	-	-	0.1	Negl	14.4	206.7

Note: The 1995 jack mackerel catch is probably a better indicator of the seasonal distribution than catches during the 1980s as the Chilean fleet expanded during the early 1990s and now takes the species over a much greater portion of the species' range.
* Regions delineated in map 2.
Source: SERNAP, *Anuario Estadístico de Pesca*, 1995.

Appendix B2d.--Southeastern Pacific (FAO area 87). Jack mackerel catch, 1986-94

Country	Year									
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	Million metric tons									
Bulgaria	-	-	-	-	Negl	-	-	-	-	-
Chile	1.2	1.8	2.1	2.4	2.5	3.0	3.2	3.2	4.0	4.4
Cuba	Negl	Negl	Negl	Negl	Negl	Negl	Negl	-	-	-
Ecuador	-	-	-	Negl	Negl	Negl	Negl	Negl	Negl	0.2
Estonia	SC	SC	Negl	Negl	Negl	0.1	Negl	-	-	-
Georgia	SC	SC	Negl	Negl	Negl	Negl	-	-	-	-
Japan	Negl	Negl	Negl	Negl	Negl	-	-	-	-	-
Korea	-	Negl	-	-	-	-	-	-	-	-
Latvia	SC	SC	0.1	0.1	0.1	0.1	Negl	-	-	-
Peru	Negl	Negl	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.4
Russia	SC	SC	0.5	0.7	0.7	0.4	Negl	-	-	-
Ukraine	SC	SC	0.1	0.1	0.1	0.1	-	-	-	-
USSR	0.7	0.8	SC	SC	SC					
Total	2.0	2.7	3.2	3.7	3.8	4.0	3.4	3.5	4.3	5.0

NA - Not available
SC - Statisical change: Beginning in 1988 the Soviet catch is reported by countries of the former union.
Source: FAO, *Yearbook of Fishery Statistics*, various years.

Appendix B3.--Chile. Monthly sea-surface-temperature (SST) ranges in the Valparaíso swordfish fishing zone, 1987-88

Months	Year	
	1987*	1988
	SST°C	
January	NA	19.0
February	NA	16.7-18.8
March	18.0-20.0	17.0-19.0
April	15.0-19.0	15.5-18.0
May	15.0-16.5	13.7-16.5
June	13.5-15.5	14.0-15.5
July	13.7-14.0	14.5
August	14.0	13.7-15.0

- Not available
* Chile affected by an El Niño event
Source: M. Angela Barbieri, Eleuterio Yáñez R., Luis Ariz A., Antonio González C., "La pesquería del pez espada: Tendencias y perspectivas," in *Perspectivas de la Actividad Pesquera en Chile* (Escuela de Ciencias del Mar, UCV: Valparaío, Chile, 1990), p. 206.

Appendix B4.--Chile. Seasonal sea color fluctuations in the Valparaíso swordfish fishing zone, 1988

Color	Season*		
	Summer	Fall	Winter
		Percent**	
Blue	10.6	17.2	9.5
White	12.8	4.9	40.5
Celeste	44.7	13.6	31.0
Green	31.9	64.2	19.0

* Chilean seasons:
Summer: January-March
Fall: April-May
Winter: May-September
Spring: October-December (little fishing takes place in the Spring, see appendix E2c1).
** Relative occurance of swordfish
Source: M. Angela Barbieri, Eleuterio Yáñez R., Luis Ariz A., Antonio González C., "La pesquería del pez espada: Tendencias y perspectivas," in *Perspectivas de la Actividad Pesquera en Chile* (Escuela de Ciencias del Mar, UCV: Valparaío, Chile, 1990), p. 206.

Appendix B5a1.--Chile. Biometric relationship of the swordfish landed in Valparaíso, 1987

Measure		Intercept	Slope	Fish	Variability
Linear(X)	Weight(Y)	(a)	(b)	measured	
LHMI	PTR	1.08 E4	2.57	39	72.3
LHO	PTR	1.47 E4	2.56	51	77.0
LC	PTR	1.48 E4	2.69	1,067	83.7
PER	PTR	1.28 E3	2.40	460	72.1

Note: Length and weight conversions can be estimated by using the following equation: $Y = a * X^b$
Explanation: The a and b entries in the above table are the y axis intercept (a) and the line slope (b) taken from a graph of the length and weight of measured fish.
Measurements:
LHMI - Length measured from the lower mandible to the tail fork
LHO - Length measured from the eye to the tail fork
LC - Trunk length measured from the rear section of the first dorsal fin to the upper grove of the caudal peduncle
PER - Trunk circumference
PTR - Trunk weight
Source: M. Angela Barbieri, Eleuterio Yáñez R., Luis Ariz A., Antonio González C., "La pesquería del pez espada: Tendencias y perspectivas," in *Perspectivas de la Actividad Pesquera en Chile* (Escuela de Ciencias del Mar, UCV: Valparaío, Chile, 1990), p. 210.

Appendix B5a2.--Chile. Biometric relationship of the swordfish landed in Valparaíso, 1988

Measure Linear(X)	Weight(Y)	Intercept (a)	Slope (b)	Fish measured	Variability
LHMI	PTR	2.46 E6	3.28	20	82.0
LHO	PTR	2.01 E6	3.37	22	84.1
LC	PTR	5.46 E5	2.89	883	90.3
PER	PTR	8.65 E5	2.92	717	86.6

Note: Length and weight conversions can be estimated by using the following equation: $Y = a * X^b$
Explanation: The a and b entries in the above table are the y axis intercept (a) and the line slope (b) taken from a graph of the length and weight of measured fish
Measurements:
LHMI - Length measured from the lower mandible to the tail fork
LHO - Length measured from the eye to the tail fork
LC - Trunk length measured from the rear section of the first dorsal fin to the upper grove of the caudal peduncle
PER - Trunk circumference
PTR - Trunk weight
Source: M. Angela Barbieri, Eleuterio Yáñez R., Luis Ariz A., Antonio González C., "La pesquería del pez espada: Tendencias y perspectivas," in *Perspectivas de la Actividad Pesquera en Chile* (Escuela de Ciencias del Mar, UCV: Valparaío, Chile, 1990), p. 210.

Appendix B5b1.--Chile. Swordfish sizes, fish landed in Valparaíso, 1987

Measurement	Fish measured	Range	Average
	Number		
Whole fish			
Length-LHMI	59	149-280 cm	228 cm
Length-LHO	73	130-270 cm	207 cm
Trunk			
Length-LC*	1,212	97-261 cm	161 cm
Circumference*	590	65-172 cm	123 cm
Weight*	1,386	16-318 kg	138 kg

Measurements:
LHMI - Length measured from the lower mandible to the tail fork
LHO - Length measured from the eye to the tail fork
LC - Trunk length measured from the rear section of the first dorsal fin to the upper grove of the caudal peduncle
* Measures of trunks are available in much larger numbers than the whole fish because the measurements do not have to be taken at the time the fish are brought aboard.
Source: M. Angela Barbieri, Eleuterio Yáñez R., Luis Ariz A., Antonio González C., "La pesquería del pez espada: Tendencias y perspectivas," in *Perspectivas de la Actividad Pesquera en Chile* (Escuela de Ciencias del Mar, UCV: Valparaío, Chile, 1990), p. 208.

Appendix B5b2.--Chile. Swordfish sizes, fish landed in Valparaíso, 1988

Measurement	Fish measured	Range	Average
	Number		
Whole fish			
Length-LHMI	23	172-294 cm	223 cm
Length-LHO	25	157-262 cm	207 cm
Length-LC*	1,006	91-235 cm	156 cm
Trunk			
Circumference*	834	59-194 cm	126 cm
Weight*	1,305	19-390 kg	129 kg

Measurements:
LHMI - Length measured from the lower mandible to the tail fork
LHO - Length measured from the eye to the tail fork
LC - Trunk length measured from the rear section of the first dorsal fin to the upper grove of the caudal peduncle
* Measures of trunks are available in much larger numbers than the whole fish because the measurements do not have to be taken at the time the fish are brought aboard.
Source: M. Angela Barbieri, Eleuterio Yáñez R., Luis Ariz A., Antonio González C., "La pesquería del pez espada: Tendencias y perspectivas," in *Perspectivas de la Actividad Pesquera en Chile* (Escuela de Ciencias del Mar, UCV: Valparaío, Chile, 1990), p. 208.

Appendix B5c1.--Chile. Swordfish size ranges, 1991-92

Month	1991		1992	
	Samples	Range*	Samples	Range*
	Number	Centimeters	Number	Centimeters
January			1	88
February			3	165-189
March	16	133-306	25	130-283
April	18	150-282	10	176-299
May	6	233-294	47	147-327
June	25	164-274	25	164-297
July	1	255	13	160-270
August	29	158-272		
September	22	165-276		

Note: Samples were mostly obtained from artisanal fishermen which would mean primarily fish from the driftnet fishery, presumably in the Concepción and Valparaíso areas.
Total samples: 241
Range: 88-327 cm, but most were 175-250 cm and averaged 216.7 cm. Actual distribution by size is available on page 27 of source.
* LHMI: - Length measured from the lower mandible to the tail fork
Source: José Miguel Donoso and Javier Chong Lay-Son, "Determinación de edad y estimación de crecimiento en albacora (*Xiphias gladius*, L). Etapa I. Determinar la factibilidad de utilizar el metodo de lectura de
marcas, bandas o annuli que se forman en estructuras duras, para determinar edad," *IFOP* (no series title) (IFOP: Valparaíso, 1992), pp. 9 and 24.

Appendix B5c2.--Chile. Swordfish size ranges, 1992

Month	Sample	Size	
		Range	Average
	Number	Kilograms*	
March	243	127-137	133
April	1,184	120-125	123
May	1,434	114-118	116
June	1,057	113-119	115
July	437	104-109	107

Note: Data entries estimated from a graphic.
* Trunk weight
Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesqueria de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993, p. 67.

Appendix B5d.--Chile. Swordfish age/size relationship, by sex, 1994-95

Sex/ age	Samples	Size category
Years	Number	Centimeters
Females		
1	15	105-108/113-140
2	33	129-172
3	33	145-184
4	34	161-212
5	33	181-216/209-212
6	24	193-196/209-240
7	32	201-204/209-252
8	13	221-224/237-252/257-260
9	16	229-236/241-260/265-268/281-288
10	9	253-284
11	5	253-256/269-272/285-288
12	3	257-260/273-276
13	4	261-264/269-276
14	1	253-256
15	1	273-276
	256	
Males		
1	19	113-140
2	62	117-164
3	60	141-192
4	35	157-160/165-208
5	24	157-160/165-168/173-220
6	22	165-172/185-200/205-208/213-236
7	8	209-212/217-228/233-244/237-244
8	3	237-244
9	5	237-240/245-248/257-260
10	1	249-252
11	1	265-268
	240	

Note: Data from 256 samples taken on both longliners and drifnet vessels. Additional details on the number of individuals for each size range available in source.
Length measurements: LMIH
Source: Miguel Donoso P. and Javier Chong L-S, "Elaboración clave talla-edad de la albacora (*Xiphias gladius* L.) durante la temporada de pesca, 1994-1995," *IFOP*, no series title (IFOP: Valparaíso, November, 1995), pp. 10-11.

Appendix B5e.--Chile. Swordfish size by sex and fleet, 1994-95

Fleet	Sex	Size		Standard deviation
		Range	Average	
		Centimeters		Centimeters
Driftnet	Male	170-245	198	22
	Female	164-290	238	27
Longline	Male	114-273	163	36
	Female	108-286	181	39

Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones, 1994,)" Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 63.

Appendix B5g1.--Chile. Swordfish distribution by size, 1994-95

Trunk weight	Drift net			Longline		
	Samples	Landings	Proportion**	Samples	Landings	Proportion**
Kilograms	Individuals	Kilograms*	Percent	Individuals	Kilograms	Percent
10	-	-	-	431	4,310	0.8
20	4	80	Negl	651	13,020	2.3
30	22	660	0.1	343	10,290	1.8
40	41	1,640	0.3	227	9,080	1.6
50	105	5,250	0.9	107	5,350	1.0
60	113	6,780	1.1	51	3,060	0.5
70	149	10,430	1.7	46	3,220	0.6
80	165	13,200	2.2	47	3,760	0.7
90	199	17,910	3.0	21	1,890	0.3
100	190	19,000	3.2	33	3,300	0.6
110	193	21,230	3.6	18	1,980	0.4
120	190	22,800	3.8	23	2,760	0.5
130	186	24,180	4.0	8	1,040	0.2
140	168	23,520	3.9	14	1,960	0.4
150	150	22,500	3.8	4	600	0.1
160	105	16,800	2.8	6	960	0.2
170	97	16,490	2.8	5	850	0.2
180	78	14,040	2.3	4	720	0.1
190	79	15,010	2.5	3	570	0.1
200	69	13,800	2.3	1	200	Negl
210	43	9,030	1.5	-	-	-
220	14	3,080	0.5	1	220	Negl
230	20	4,600	0.8	-	-	-
240	14	3,360	0.6	2	480	0.1
250	12	3,000	0.5			
260	9	2,340	0.4			
270	7	1,890	0.3			
280	6	1,680	0.3			
290	1	290	Negl			
300	3	900	0.2			
310	1	310	0.1			
320	2	640	0.1			
330	1	330	0.1			
340	-	-	-			
350	1	350	0.1			
360	1	360	0.1			
370	-	-	-			
380	-	-	-			
390	-	390	0.1			
Total	2,439	597,830	50.0	2,046	557,989	12.5

* Trunk weight

** Proportion of landed quantity (tonnage) sampled. This was a very extensive study including an impressive sample. The sample included 50 percent of the driftnet catch and 12.5 percent of the longline catch.

Source: Miguel Donoso P. and Javier Chong L-S, "Elaboración clave talla-edad de la albacora (*Xiphias gladius* L.) durante la temporada de pesca, 1994-1995," *IFOP*, no series title (IFOP: Valparaíso, November, 1995), p. 13.

Appendix B5g2.--Chile. Swordfish size by fishing gear, landings in Valparaíso during 1987-88

Gear	1987		1988	
	Fish	Weight*	Fish	Weight*
	Number	Kilograms	Number	Kilograms
Harpoon	216	152	316	152
Driftnet	669	133	907	122

* Average trunk weight
Source: M. Angela Barbieri, Eleuterio Yáñez R., Luis Ariz A., Antonio González C., "La pesquería del pez espada: Tendencias y perspectivas," in *Perspectivas de la Actividad Pesquera en Chile* (Escuela de Ciencias del Mar, UCV: Valparaío, Chile, 1990), p. 208.

Appendix B5g3.--Chile. Average trunk size by fishing zone, 1994-95

Year/ month	Driftnets/Zone*							Longlines/Zone*		
	1	2	3	4	5	6	Total	1	3	Total
	Kilograms**							Kilograms**		
1994										
June	-	128	144	119	-	110	119	-	65	65
July	-	146	117	126	-	112	117	53	71	56
August	-	129	114	120	-	147	117	29	-	29
September	-	-	117	-	-	-	117	38	40	38
October	-	-	-	-	-	-	-	42	-	42
November	-	-	-	-	-	-	-	17	-	17
December	-	-	-	-	-	-	-	20	-	20
1995										
January	-	-	-	-	-	-	-	19	-	19
February	-	-	-	-	-	-	-	29	-	29
March	-	121	155	126	-	97	108	37	-	37
April	-	96	129	130	-	126	120	28	-	28
May	108	92	74	110	-	97	98	76	71	72
June	-	68	128	117	-	128	106	62	80	75
July	-	-	-	133	-	-	133	73	-	73
Total	108	88	122	121	-	109	114	33	75	40

* Zones delieneated in map 3.
** Trunk weight
Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones), 1994," Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 59.

Appendix B5g4.--Chile. Average trunk size, by port 1988-90

Region/ port	1988			1989			1989		
	Fish	Trunks	Variance*	Fish	Trunks	Variance*	Fish	Trunks	Variance*
	Number	Kilograms		Number	Kilograms		Number	Kilograms	
III-Caldera	114	76	NA	79	106	1.4	NA	NA	NA
V-Valparaío	1,305	129	NA	16	123	3.2	1,845	125	2.5
V-San Antonio	263	124	NA	2,695	127	4.0	524	100	2.8
VIII-San Vincente	NA	NA	NA	NA	NA	NA	206	168	5.1
VIII-Lebu	NA	NA	NA	1,089	171	5.5	328	164	4.4

* Standard deviation can be calculated by taking the square root of the variance.
Source: M. Angela Barbieri,, Eleuterio Yáñez R., Luis Ariz A., Antonio González C., "La pesquería del pez espada: Tendencias y perspectivas," in *Perspectivas de la Actividad Pesquera en Chile* (Escuela de Ciencias del Mar, UCV: Valparaío, Chile, 1990), p. 209 (1988 data) and Francisco Ponce Martínez and René Bustos, "La pesquería de pez espada *Xiphias gladius* Linnaeus, 1758 en Chile," *Revista Pacifífico Sur*, No. 19, 1991, p. 31 (1899-90 data).

Appendix B5g5.--Chile. Average trunks sizes of swordfish received in San Antonio plants, 1988-90

Month	Year		
	1988	1989*	1990
		Kilograms	
January	-	180.1	-
February	139.0	174.1	169.9
March	160.6	131.6	149.5
April	139.3	130.7	132.3
May	136.2	130.7	130.8
June	130.4	112.6	135.3
July	113.0	115.8	-
August	146.0	-	-
Average	137.8	139.4	144.6

* Data provided by the Asociación de Exportadores de Albacora
Source: Francisco Ponce Martínez and René Bustos, "La pesquería de pez espada *Xiphias gladius* Linnaeus, 1758 en Chile," *Revista Pacifífico Sur*, No. 19, 1991, p. 31.

Appendix B5g6.--Chile. Average weights, 1994-95

Gear/ month	Port							Average
	Caldera	Coquimbo	Valparaíso	S. Antonio	Constitución	Talcahuano	Lebu	
	Kilograms (PTRO)#							
Driftnets								
1994								
June	118*	-	120	112	180	107	110	121
July	148*	-	109	119	175	137	108	117
August	136*	116	115	115	168	-	-	117
September	-	-	117	-	-	-	-	117
October	-	-	-	-	-	-	-	-
November	-	-	-	-	-	-	-	-
December	-	-	-	-	-	-	-	-
1995								
January	-	-	-	-	-	-	-	-
February	-	-	-	-	-	-	89	89
March	121*	-	125	153	-	-	94	107
April	96**	-	133	133	-	116	140	123
May	95**	-	117	98	-	104	90	97
June	68**	-	115	131	-	118	146	107
July	-	-	133	-	-	-	-	133
Total	89	116	118	122	176	114	106	114
Longline								
1994								
June		-	58					58
July		53	71					57
August		29						29
September		38						38
October		42						42
November		17						17
December		20						20
1995								
January		19						19
February		29						29
March		37						37
April		28						28
May		72	65					71
June		71	93	97				79
July		69						69
Total		37	73	97				40

PTRO - Trunk weight

* The relatively large fish landed at Caldera during these months are in part due the use of harpoons as the principal fishing gear. The actual quantity of fish landed, however,was relatively small.

** The average size of the fish declined in April, 1995 when several driftnet vessels began to operate from Caldera.

Regions:

Caldera: Region III
Coquimbo: Region IV
Valparaiso: Region V
San Antonio: Region V
Constitución: Region VII
Talcahuano: Region VIII
Lebu: Region VIII

Note: Details on numbers of samples taken available in source indicated below, page 53.

Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones, 1994,)" Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 55.

Appendix B5h1.--Chile. Size frequency of artisanal swordfish catches*, 1987-93

Year	Sample	Average size
	Number	Kilograms**
1987	915	138
1988	1,223	137
1989	3,967	140
1990	5,081	136
1991	5,229	124
1992	4,985	117
1993	5,088	102
1994		
1995		

* Data from the artisanal fleet operating out of Valparaiso and San Antonio.
Source: M. A. Barbieri, M. Donoso, A. Gonzalez, V. Correa, B. Leiva, and A. Montiel, "Development and state of art of the swordfish fishery in Chile", paper delivered at the International Symposium on Pacific Swordfish, Ensenada, B.C., Mexico, December 11-14, 1994, figures 7a-g.

Appendix B5h2.--Chile. Size frequency of commercial swordfish catches, 1992

Size	Proportion
Kg*	Percent
<30	26
31-60	27
61-90	16
91-120	12
121-150	9
151-180	5
181-210	2
211-240	2
241-270	-
271-300	1
301-380	-
Total	100

Note: Data entries estimated from a graphic.
* Trunk weight
Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesqueria de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993, p. 67.

Appendix B6a.--Chile. Swordfish catch, by year class, 1994-95

Year class	Individuals	Size*		Proprtion**	Variation***
		Average	Range		
Year	Number	Centimters		Percent	Centimeters
1	758	126.5	125-128	8.7	Negl
2	1,209	147.3	125-164	13.8	62.2
3	1,368	164.9	145-192	15.6	157.8
4	723	187.3	161-212	8.3	151.5
5	1,144	201.8	173-220	13.1	114.7
6	1,191	220.8	189-240	13.6	107.9
7	1,346	228.6	201-252	15.4	120.2
8	284	240.9	221-272	3.2	105.2
9	404	245.3	229-284	4.6	89.3
10	148	259.1	249-288	1.7	60.7
11	68	257.4	253-288	0.8	44.3
12	12	268.0	257-276	0.1	45.0
13	44	264.4	261-276	0.5	15.6
14	59	256.9	253-292	0.7	81.4
15	5	281.8	273-296	0.1	113.7
	8,761		125-296	100.0	

Note: The above data was collected from both longliners and driftnet vessels and includes comparable numbers of female and male fish. Additional details on the number of individuals for each size range available in source imdivated below.
* Length measurements: LMIH
** In terms of individuals
*** Standard deviation
Source: Miguel Donoso P. and Javier Chong L-S, "Elaboración clave talla-edad de la albacora (*Xiphias gladius* L.) durante la temporada de pesca, 1994-1995," *IFOP*, no series title (IFOP: Valparaíso, November, 1995), p. 14.

Appendix B6b.--Chile. Swordfish length age relationship, 1991-92

Age	Length calculated*	Growth	
		Absolute	Rate**
Years	Centimeters		Percent
1	117.9	117.9	-
2	145.4	27.5	23.3
3	168.8	23.4	16.1
4	189.0	20.2	12.0
5	206.3	17.3	9.2
6	221.1	14.8	7.2
7	233.7	12.6	5.7
8	244.6	10.9	4.7
9	253.9	9.3	3.8
10	261.8	7.9	3.1
11	268.7	6.9	2.6
12	274.5	5.8	2.2
13	279.5	5.0	1.8

* LHMI - Length measured from the lower mandible to the tail fork
** Growth rate over previous year.
Source: José Miguel Donoso and Javier Chong Lay-Son, "Determinación de edad y estimación de crecimiento en albacora (*Xiphias gladius*, L). Etapa I. Determinar la factibilidad de utilizar el metodo de lectura de marcas, bandas o annuli que se forman en estructuras duras, para determinar edad," *IFOP* (no series title) (IFOP: Valparaíso, 1992), p. 25.

Appendix B6c.--Chile. Swordfish weight/age relationship, 1991-92

Age	Weight		Growth	
	Calculated	Trunk*	Absolute	Rate**
Years		Kilograms		Percent
1	23.4	18.7	23.4	-
2	40.4	32.3	17.0	72.6
3	60.4	48.3	20.0	49.5
4	82.2	65.8	21.8	36.1
5	104.8	83.8	22.6	27.5
6	127.4	101.9	22.6	21.6
7	149.3	119.4	21.9	17.2
8	170.3	136.2	20.9	14.0
9	189.9	151.9	19.7	11.6
10	208.2	165.6	18.2	9.6
11	224.8	179.8	16.7	8.0
12	239.9	191.9	15.1	6.7
13	252.6	201.1	13.7	5.7

* Trunk weight are about 80 percent of the live weight.
** Growth rate over previous year.
Source: José Miguel Donoso and Javier Chong Lay-Son, "Determinación de edad y estimación de crecimiento en albacora (*Xiphias gladius*, L). Etapa I. Determinar la factibilidad de utilizar el metodo de lectura de marcas, bandas o annuli que se forman en estructuras duras, para determinar edad," *IFOP* (no series title) (IFOP: Valparaíso, 1992), p. 26.

Appendix B7.--Chile. Gonadal index (IG), 1994-95

Year/ month	Longline		Driftnet	
	Index	Samples	Index	Samples
		Number		Number
1994				
May	0.726	17		
June	0.803	9	0.449	8
July	0.865	22		
August	0.643	20		
September	0.613	9		
December	0.399	120		
1995				
April			0.869	18
May	0.307	14	0.799	38
June	0.855	21		

Total samples: 231
Note: Sexually mature fish would have values of about 3.0.
Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones, 1994,)" Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 64.

Appendix C1a1.--Chile. Swordfish fishing power, 1986-91

Year	Vessels		Driftnet#		Fishing power		Landings	
	Registered	Fishing	Length	Drop	Nets	Change*	Quantity	Change*
	Number		Brazas##		1,000 Br²**	Percent	Metric tons	Percent
1986	22	NA	500	15	165	NA	764	NA
1987	288	NA	500	15	2,160	131	2,059	270
1988	440	NA	500	15	3,300	153	4,455	216
1989	860	NA	700	20	12,040	365	5,824	131
1990	1,200###	600-700	1,000	25	30,000	249	4,060	-70
1991	1,200###	600-700	1,000	25	30,000	-	NA	NA
1992								
1993								
1994								
1995								
1996	200							

NA - Not available
Approximate averages
A "braza" or fathom is 6 feet. It is is a commonly used nautical measure in Latin America equal to about 6 feet.
The size composition of these vessels is detailed in appendix A2f.
* It is unclear to the authors how these changes were calculated. The change is relative to previous year.
** Fishing power estimated in net area (1,000 square brazas). A square braza is 3.34 square meters. The authors have not converted to metric units as the converted metric area would convey a level of accuracy beyond what should be inferred from the data.

Source: Francisco Ponce Martínez and René Bustos, "La pesquería de pez espada *Xiphias gladius* Linnaeus, 1758 en Chile," *Revista Pacifífico Sur*, No. 19, 1991, p. 29 and Francisco Ponce Martínez, SSP, personal communications,
January 8, 1997.

Appendix C1a2.--Chile. Fishing effort by port and month, 1992

Port	Vessels												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	Days out of port												
Caldera	-	3	17	62	126	45	97	92	38				480
Valparaíso	-	NA	NA	21	472	572	174	NA	NA				1,239
San Antonio	-	44	370	702	1,733	1,388	644	321	22				5,224
Constitución	6	24	324	551	321	161	38	9	20				1,454
San Vicente	-	-	27	52	40	45	-	-	-				164
Lebu	-	43	505	855	588	387	19	-	-				2,397
Valdivia	-	6	113	120	12	-	-	-	-				251
Total	6	120	1,356	2,363	3,292	2,598	972	422	80				11,209

Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesquería de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993, p. 37.

Appendix C1b2.--Chile. Swordfish fishing effort, 1992-93

Port	Season*	Month								Total
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
					Fishing trips					
San Antonio	1992	8	65	118	281	210	85	91	-	858
	1993	-	69	180	232	191	141	35	-	848
Lebu	1992	6	83	152	82	57	2	-	-	382
	1993	25	146	119	87	46	29	2	-	454
Valdivia	1992	1	22	16	2	-	-	-	-	41
	1993	-	28	12	3	-	-	-	-	43
Totals	1992	15	170	286	365	267	87	91	-	1,281
	1993	25	243	311	322	237	170	37	-	1,345

Source: IFOP, "Estado de situación y perspectivas del recurso," *Pesquerias Nacionales Demersales* (PECES), Zona Centro Sur, 1993, (Santiago: IFP, April, 1994), table 5.

Appendix C1b3.--Chile. Swordfish fishing effort, 1992-93

Port	Season*	Month								Total
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
					Days out of port					
San Antonio	1992	44	370	702	1,733	1,388	644	343	-	5,224
	1993	-	393	1,285	1,697	1,720	1,497	293	-	6,885
Lebu	1992	43	505	855	588	387	19	-	-	2,397
	1993	152	1,118	732	586	419	232	-	-	3,239
Valdivia	1992	6	113	120	12	-	-	-	-	251
	1993	-	201	88	30	-	-	-	-	319
Totals	1992	93	988	1,677	2,333	1,775	663	343	-	7,872
	1993	152	1,712	2,015	2,313	2,139	1,729	293	-	10,443

Source: IFOP, "Estado de situación y perspectivas del recurso," *Pesquerias Nacionales Demersales* (PECES), Zona Centro Sur, 1993, (Santiago: IFP, April, 1994), table 6.

Appendix C1b4.--Chile. Swordfish trips, by port, 1991

Port	Month									Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
					Trips					
San Antonio	5	14	276	96	145	232	115	82	-	965
Caldera	-	14	43	139	44	73	101	37	-	451
Constitución	1	12	128	113	46	53	64	14	1	431
Lebu	7	52	88	108	31	33	29	-	-	348
San Vicente	-	6	34	53	34	19	3	-	-	149
Valparaíso	-	-	13	33	30	28	-	-	-	104
Valdivia	-	3	3	2	-	-	-	-	-	8
Total	13	101	585	544	330	438	312	133	1	2,456

Source: José Donoso P. and Carlos Montenegro, "Inves. monitoreo pesqueria de albacora temporada 1991," (IFOP Nº inven: 920020), October 1992, p. 17.

Appendix C1c1.--Chile. Swordfish fishing yields, 1992-93

Port	Season*	Month								Total
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
		Kg per fishing trips								
San Antonio	1992	292	409	809	1,347	1,016	737	449	-	NA
	1993	-	548	960	1,180	719	889	482	-	NA
Lebu	1992	237	1,121	1,124	1,510	2,180	1,467	-	-	NA
	1993	372	634	1,245	914	1,050	563	150	-	NA
Valdivia	1992	200	1,154	1,175	NA	-	-	-	-	NA
	1993	-	1,054	1,395	1,967	-	-	-	-	NA
Totals	1992	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1993	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA - Not available
Source: IFOP, "Estado de situación y perspectivas del recurso," *Pesquerias Nacionales Demersales* (PECES), Zona Centro Sur, 1993, (Santiago: IFP, April, 1994), table 7.

Appendix C1c2a.--Chile. Swordfish fish yields, 1992-93

Port	Season*	Month								Total
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
		Kg per fishing days								
San Antonio	1992	53	72	136	218	154	97	62	-	NA
	1993	-	96	134	161	80	84	58	-	NA
Lebu	1992	33	184	200	211	321	158	-	-	NA
	1993	61	83	202	138	116	70	NA	-	NA
Valdivia	1992	33	225	157	167	-	-	-	-	NA
	1993	-	148	190	196	-	-	-	-	NA
Totals	1992	NA	NA	NA	NA	NA	NA	NA	NA	NA
	1993	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA - Not avaialble
Source: IFOP, "Estado de situación y perspectivas del recurso," *Pesquerias Nacionales Demersales* (PECES), Zona Centro Sur, 1993, (Santiago: IFP, April, 1994), table 8.

Appendix C1c3b.--Chile. Fishing yields by port and month, 1992

Port	Vessels												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	Kg/days out of port (DFP)												
Caldera		40.0	29.1	53.9	84.2	52.4	64.8	55.9	8.2				59.7
Valparaíso				224.5	70.0	120.8	72.7						96.5
San Antonio		53.2	71.9	136.1	218.5	153.7	97.4	66.2	46.4				153.4
Constitución	33.3	88.8	59.2	95.4	116.2	130.4	113.2	12.2	45.0				94.7
San Vicente			194.3	209.7	248.7	100.0							186.6
Lebu		33.1	184.4	200.0	210.6	321.2	154.5						215.5
Valdivia		33.3	224.8	203.3	166.7								207.2
Total	33.3	51.8	125.4	153.4	180.8	167.3	91.4	62.8	27.9				150.5

Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesqueria de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993, p. 38.

Appendix C2a1.--Chile. Artisanal swordfish catch, effort, and yield, 1987-93

Year	Catch	Effort	Yield*
	Metric tons	Days at sea	Kg/days at sea
1987	1,869	4,777	391
1988	3,972	16,861	236
1989	4,185	20,258	207
1990	3,850	22,232	173
1991	3,286	36,776	89
1992	2,801	30,849	91
1993	2,733	40,692	67

* Catch per unit effort (CPUE)
Source: M. A. Barbieri, M. Donoso, A. Gonzalez, V. Correa, B. Leiva, and A. Montiel, "Development and state of art of the swordfish fishery in Chile", paper delivered at the International Symposium on Pacific Swordfish, Ensenada, B.C., Mexico, December 11-14, 1994, p. 11.

Appendix C2a2.--Chile. Artisanal swordfish catch, effort, and yield, 1987-95

Year	Catch	Effort**	Yield*
	Metric tons	Days at sea	Kg/days at sea
1987	2,059	5,265	391
1988	4,455	17,200	259
1989	5,824	20,152	289
1990	4,955	18,150	273
1991	7,255	38,215	185
1992	6,379	37,305	171
1993	4,712	40,974	115
1994	3,801	38,786	98
1995	2,594	29,477	88

* Catch per unit effort (CPUE)
** Artisanal fleet
Note: The catch data is total (commercial and artisanal) while the effort data is only artisanal.
Source: SATAL II, ECM-UCV in Eleuterio Yáñez R., "Estado de situación de la pesqueria del pez espada en Chile," *Boletín Apropech*, No. 16, January-March, 1997, in press.

Appendix C2a3.--Chile. Artisanal (driftnet) swordfish effort and yield, 1989-96

Year	Effort	Yield*
	Days at sea	Kg/days at sea
1989	7,579	178
1990	6,226	158
1991	11,450	156
1992	11,209	150
1993	10,755	115
1994	8,393	104
1995	8,152	93
1996	7,041	100

* Catch per unit effort (CPUE)
Source: Miguel Donoso, IFOP, personal communications, August 26, 1997.

Appendix C2b.--Chile. Swordfish yields by port, 1989-92

Port	Year			
	1989	1990	1991	1992
	Kg/Days out of port			
Caldera	81	61	90	59
Valparaíso	148	194	251	96
San Antonio	149	136	124	153
Constitución	223	183	138	94
San Vicente	334	220	279	186
Lebu	388	284	276	215
Valdivia	204	174	91	207
Total	178	158	156	150

Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesqueria de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993, p. 39.

Appendix C2c1.--Chile. Artisanal fishing effort and yields, by port, 1994

Port	1994				Total/
	Jun	Jul	Aug	Sep	average
	Days out of port (DFP)				
Effort					Total
Caldera	40	7	13	-	60
Coquimbo	-	36	433	-	469
Valparaíso	794	528	642	206	2,170
San Antonio	631	1,018	267	-	1,916
Constitución	261	164	33	-	458
Talcahuano	146	9	82	12	249
Lebu	319	260	-	-	579
Total	2,191	2,022	1,470	218	5,901
Yield	Kg/DFP				Average
Caldera	29	63	25	-	32
Coquimbo	-	116	101	-	102
Valparaíso	109	99	79	48	92
San Antonio	110	95	124	-	104
Constitución	94	101	91	-	96
Talcahuano	158	139	143	82	149
Lebu	109	128	-	-	118
Total	110	101	97	50	101

DFP - Days out of port ("dias fuera del puerto.")
Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones, 1994,)" Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 45.

Appendix C2c2.--Chile. Artisanal fishing effort and yields, by port, 1995

Port	1995						Total/
	Feb	Mar	Apr	May	Jun	Jul	average
				DFP			
Effort							Total
Caldera	-	82	408	246	108	-	844
Coquimbo	-	-	-	43	158	606	807
Valparaíso	9	51	317	328	112	51	868
San Antonio	-	142	531	690	808	116	2,287
Constitución	17	104	176	127	61	65	550
Talcahuano	-	-	-	11	237	58	306
Lebu	96	603	837	519	395	40	2,490
Total	122	982	2,269	1,964	1,879	936	8,152
Yield				Kg/DFP			Average
Caldera	-	87	35	71	117	-	61
Coquimbo	-	-	-	77	129	122	121
Valparaíso	82	67	117	66	93	48	87
San Antonio	-	88	73	76	88	57	79
Constitución	47	54	66	89	87	53	69
Talcahuano	-	-	-	191	114	114	117
Lebu	55	82	88	135	181	105	110
Total	56	79	76	91	116	103	93

DFP - Days out of port ("dias fuera del puerto.")
Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones, 1994,)" Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 46

Appendix C2d.--Chile. Artisanal fishing effort and yields, by zone*, 1994

Zone	1994				Total/
	Jun	Jul	Aug	Sep	average
			DFP		
Effort					Total
2	40	7	13	-	60
3	178	435	999	154	1,766
4	1,306	1,180	257	48	2,791
5	10	15	-	-	25
6	657	385	201	16	1,259
Total	2,191	2,022	1,470	218	5,901
Yield			Kg/DFP		Average
2	29	63	25	-	32
3	141	91	102	64	100
4	116	103	82	22	106
5	71	212	-	-	156
6	94	104	94	Negl	96
Total	110	101	97	50	101

DFP - Days out of port ("dias fuera del puerto")
* Zones delineated in map 3.
Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones, 1994," Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 48.

Appendix C2e.--Chile. Artisanal fishing effort and yields, by zone*, 1995

Zone	1995						Total/
	Feb	Mar	Apr	May	Jun	Jul	average
				DFP			
Effort							Total
1	-	-	-	45	-	-	45
2	-	82	408	201	266	-	957
3	-	100	330	453	365	294	1,542
4	9	105	489	576	567	474	2,220
5	3	-	95	113	208	58	477
6	110	695	947	576	473	110	2,901
Total	122	982	2,269	1,964	1,874	936	8,152
Yield				Kg/DFP			Average
1	-	-	-	124	-	-	124
2	-	87	35	59	116	-	48
3	-	76	74	86	139	97	97
4	82	89	102	61	91	114	91
5	161	-	69	154	88	114	103
6	51	77	85	120	179	69	93
Total	56	79	77	91	116	103	93

DFP - Days out of port ("dias fuera del puerto)
* Zones delineated in map 3.
Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones, 1994,)" Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 49.

Appendix C3a.--Chile. Commercial fishing effort and yields, by port, 1994

Port	1994							Total/
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	average
				1,000 Hooks				
Effort								Total
Coquimbo	190.6	209.3	338.1	214.9	229.3	142.4	136.0	1,460.5
Yield				Kg/hook				Average
Coquimbo	0.62	0.44	0.40	0.28	0.29	0.23	0.40	0.38

Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones, 1994,)" Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 47.

Appendix C3b.--Chile. Commercial fishing effort and yields, by port, 1995

Port	1995							Total/
	Jan	Feb	Mar	Apr	May	Jun	Jul	average
				1,000 hooks				
Effort								Total
Coquimbo	41.1	23.3	69.8	89.1	60.9	120.3	32.5	436.9
Yield				Kg/hook				Average
Coquimbo	0.36	0.50	0.56	0.56	0.74	0.39	0.45	0.51

Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones, 1994,)" Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 47.

Appendix C3c.--Chile. Commercial fishing effort and yields, by zone*, 1994

Zone	1994							Total/
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	average
				1,000 hooks				
Effort								Total
1	-	154.9	237.9	187.9	229.3	142.4	136.0	1,088.4
3	190.6	54.3	100.2	27.0	-	-	-	372.1
Total	190.6	209.2	338.1	214.9	229.3	142.4	136.0	1,460.5
Yield				Kg/hook				Average
1	-	0.39	0.33	0.30	0.29	0.23	0.40	0.32
3	0.62	0.57	0.57	0.14	-	-	-	0.56
Total	0.62	NA	NA	NA	0.29	0.23	0.40	NA

NA - Not available
* Zones delineated in map 3.
Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones), 1994," Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 50.

Appendix C3d.--Chile. Commercial fishing effort and yields, by zone*, 1995

Zone	1995							Total/
	Jan	Feb	Mar	Apr	May	Jun	Jul	average
				1,000 hooks				
Effort								Total
1	41.1	23.3	69.8	89.1	15.5	-	-	238.8
3	-	-	-	-	45.4	120.3	32.5	198.1
Total	41.1	23.3	69.8	89.1	60.9	120.3	32.5	
Yield				Kg/hook				Average
1	0.36	0.50	0.56	0.56	1.34	-	-	0.57
3	-	-	-	-	0.53	0.39	0.45	0.43
Total	0.36	0.50	0.56	0.56	NA	0.39	0.45	NA

NA - Not available
* Zones delineated in map 3.
Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González
Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones), 1994," Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 50.

SERIES D APPENDICES: FLEET OPERATIONS

D1: Overall swordfish operations and gear
D2: Artisanl swordfish operations
D3: Commercial swordfish operations
D4: Foreign operations

Appendix D1a.--Chile. Swordfish fleet operations, commonly reported activities, 1994-95

Activity	Fleet	
	Longline	Driftnet
Fishing grounds		
Time	40-70 hours	15-30 hours
Distance	500 kilometers#	80-250 kilometers##
Time searching	6 hours	2-7 hours
Depths	30-55 meters+	9-55/60 meters
Duration of deployment ("calado")	5-7 hours	1-3 hours
Duration of retrival ("virado")	10-12 hours	3-6 hours
Soak time (gear left active)	6-8 hours	8-12 hours*/24 hours**
Total duration of set	21-27 hours	18-36 hours
Trip length	15-18/20 days***	8-12 days
Number of trips per month	1 trip per month	1-2 trips per month
Number of trips per season	9-10 trips	10-15 trips
Number of sets per trip	11-15 sets per trip###	4-8 sets per trip
Crew	About 20 persons	About 6-8 persons

Note: Detailed descriptions of the gear and fishing operations are availavle in the text of the report ("Gear and Fishing Operations.")
NA - Not applicable
Some trips are up to 1,300 kilometers. The artisanal fishermen do not currently go beyond 500 kilometers.
A few of the artisanal driftnet fishermen may ocasionaly go out beyond the 200-mile (320 km) limit, but this is highly unusual.
Currently the entire fleet is deployed for fresh fish which limits trips to a maximum of 15-18 days. another source indicates an average of 20 days. Some longliners are staying longer on the grounds, up to about 25 days, and freezing some of the catch. On such long trips, as many as 20 sets would be theoretically possible, but in practice rarely achieved.
* Vessels longer than 16 meters
** Vessels smaller than 16 meters
*** This would be the upper limit of the longliners landing fresh fish; those landing frozen fish could stay at sea longer. Chilean sources indicate that in 1996 all of the Chilean longliners were landing primarily fresh product.
+ Fishermen using American methods generally do not make shallow sets and may make sets of up to 90 meters.
Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones), 1994," Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), pp. 13-14 and 38; M. Angela Barbieri Bellolio, IFOP, personal communications, January 3, 1997; Francisco Ponce, SSP, personal communications, January 8, 1997; and various other descriptions.

Appendix D1b1.--Chile. Swordfish gear, commonly reported characteristics, 1994-95

Gear	Fleet	
	Longline	Driftnet
Hooks	600-2,500 hooks	NA
Mesh	NA	50-56 centimeters
Length	40-55 kilometers	0.7-2.4 kilometers
Depth	33-55 meters	30-60 meters

Note: Detailed descriptions of the gear and fishing operations are availavle in the text of the report ("Gear and Fishing Operations.")
NA - Not applicable
Source: Various.

Appendix D1b2.--Chile. Swordfish driftnet sizes, 1992

Size	Proportion
1,000 Br*	Percent
7.0-9.0	1
9.1-11.0	10
11.1-13.0	19
13.0-15.0	15
15.1-17.0	9
17.1-19.0	11
19.1-21.0	14
21.1-23.0	9
23.1-25.0	7
25.1-27.0	5
27.1-29.0	1
29.1-31.0	1

Note: Data entries estimted from graphic.
* Br - Braza (fathom)
Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesqueria de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993, p. 61.

Appendix D2a.--Chile. Swordfish trips per artisanal vessel, 1989-90

Month	Region*	
	V	VIII
	Trips per vessel	
January	1.0	1.7
February	1.8	1.7
March	2.7	2.0
April	2.2	3.2
May	3.2	2.9
June	1.7	2.4
July	1.7	1.1
August	1.7	-

Note: Entries estimated from a graphic.
* Regiones delineated in map 2.
Source: Francisco Ponce Martínez and René Bustos, "La pesquería de pez espada *Xiphias gladius* Linnaeus, 1758 en Chile," *Revista Pacifífico Sur*, No. 19, 1991, p. 30.

Appendix D2b1.--Chile. Swordfish artisanal fishing trip duration, 1989

Region/ port	Trip duration
	Days*
V	
Valparaíso	3
San Antonio	3
VII	
Constitución	3
VIII	
Lebu	3
Valdivia	4

* Average
Source: Francisco Ponce Martínez and René Bustos, "La pesquería de pez espada *Xiphias gladius* Linnaeus, 1758 en Chile," *Revista Pacifífico Sur*, No. 19, 1991, p. 30.

Appendix D2b2.--Chile. Swordfish artisanal fishing trip duration, 1989-92

Year	Trip duration	
	Range	Average
	Days	
1989	3.1-4.1	3.7
1990	3.3-4.5	3.9
1991	4.4-6.0	5.3
1992	5.6-7.4	6.9

Note: Data entries estimted from graphic.
Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesqueria de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993, p. 59.

Appendix D2c.--Chile. Swordfish artisanal crews, 1992

Crews	Proportion
Members	Percent
5	10.8
6	30.3
7	37.0
8	15.7
9-11	6.3

Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesqueria de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993, p. 58.

Appendix D3.--Chile. Commercial swordfish vessel operations, 1992

Gear/ vessel	Trips	Catch	Yield
	Number	Metric tons	Tons/trip
Driftnet			
Carlos Darwin	3	4.7	1.6
Pacific Sea	5	8.2	1.6
Pinguin	6	13.1	2.2
Vama II	11	25.9	2.4
Total/average	25	51.9	2.1
Longline			
Areamilla	4	67.0	16.8
Blue	7	26.7	3.8
Brisca	NA	NA	NA
Canadelo	1	10.0	10.0
Kofuku Maru	3	30.4	10.1
Marazul XI	NA	NA	NA
Marazul XII	1	39.0	39.0
Marazul XVI	1	16.2	16.2
(Las) Nieves	6	116.0	19.3
Portugal II	6	123.0	20.5
Talcan	NA	NA	NA
Total/average	29	428.3	14.8
Multiple gear (driftnet and longline)			
Lucia	10	28.8	2.9
Total	64	509.0	8.0

Source: José Donoso P. and Carlos Montenegro, "Investigación monitoreo pesqueria de albacora temporada 1992," (IFOP Nº inven: 930009), June, 1993

Appendix D4.--Chile. Foreign fishing vessels entering Chilean waters, 1996-June 97

Country/ vessel	Date	Entered Lat. °S	Entered Long. °W	Map reference	Destination	Date	Exited Lat. °S	Exited Long. °W	Map reference	Observations
Argentina										
Lugo										
	7/22/96	55	65	Beagle Channel	Callao (Peru)	NA	NA	NA	NA	ETA Calao, 8/7/96, LOA 74 m TRG 1253
Rikuzen										
	7/4/96	56	75	Souhern straights	NA	7/5/96	56	66	Southwest channel	
	7/13/96	56	77	Southern straights	NA	7/14/96	55	76	Southeast channel	Called, but no reply
Yamato										
	7/5/97	55	65	Beagle Channel	Argentine ZP	7/5/96	56	67	South channel	Several radio reports
Honduras										
Urgora										
	4/20/97	39	80	Isla Mocha	Talcahuano	4/23/97	NA	NA	Talcahuano	Disembark injured crew member
Spain										
Carvisa										
	4/26/96	52	68	Punta Dungeness	Caladero	5/1/96	39	78	North of Valdivia	LOA 40-mile surface longline
	6/5/96	37	78	Coronel	NA	6/7/96	30	78	South of Coquimbo	
Depredador										
	5/15/96	31	83	I. Juan Fernandez	NA	5/17/96	37	79	Concepción	
	9/6/96	45	80	Puerto Aysen	Montevideo (Urg.)	NA	NA	NA		
Espadarte										
	4/9/97	52	68	Punta Dungeness	Caladero	4/13/97	42	78	Puerto Montt	
	5/31/97	37	80	Coronel	FZ change	6/2/97	30	77	South of Coquimbo	
	7/8/97	20	74	Iquique	Ilo (Peru)	7/8/97	18	72	Arica	Cargo of frozen fish (120 t)
	7/12/97	18	71	Arica	Iquique	NA	NA	NA	NA	Arrive Iquique 7/12/97
Juanitoba I										
	3/18/96	52	68	Punta Dungeness	Punta Arenas	NA	NA	NA	NA	Final destination Pacific fishing grounds
	3/27/96	37	79	Coronel	NA	NA	NA	NA	NA	Called but no reply, 4/6/96
	4/14/96	30	82	Tongoy	Caladero	NA	NA	NA	NA	Caladeros 40°S (VALD) 81°W, 4/16/96
	8/22/96	29	82	South of Isla Choros	High seas	8/23/96	26	83	Antofagasta	Change of direction on 4/23 to 270 to leave
	4/3/97	45	78	Puerto Aysen	High seas	5/6/96	28	77		
	5/3/97	37	81	Coronel	Highseas	5/6/97	28	77	South of Caldera	
	6/3/97	26	74	South of Taltal	Coquimbo	NA	NA	NA	NA	Arrived in Coquimbo about 6/4/97
	6/5/97	25	74	Taltal	Coquimbo	NA	NA	NA	NA	Arrived in Coquimbo about 6/6/97

Maicoa										
	3/19/96	52	68	Punta Dungeness	Punta Arenas	NA	NA	NA	NA	Waiting for "practicos"
	6/4/96	29	81	South of Isla Choros	Ilo (Peru)	6/6/96	24	77	Antofagasta	
	6/7/96	20	73	Iquique	Ilo (Peru)	6/8/96	18	72	Arica	
	6/17/96	18	70	Arica	Arica	NA	NA	NA	NA	Bethed en Arica 6/17/96
	9/7/96	31	83	Tongoy	Punta Arenas	9/9/96	37	81	Coronel	
	9/11/96	43	79	Quellon	Punta Arenas	NA	NA	NA	NA	
	2/27/97	52	68	Punta Dungeness	Fishing grounds	3/2/97	40	81	Valdivia	
	5/16/97	37	79	Coronel	Fishing grounds	5/18/97	30	76	South of Coquimbo	
	6/13/97	18	71	North of Arica	Arica	NA	NA	NA	NA	Arrived at Arica 6/14/97
Maicoa I										
	4/1/96	52	68	Punta Dungeness	Punta Arenas	NA	NA	NA	NA	90 tons of frozen horse mackerel
	5/19/96	38	78	Isla Mocha	Talcahuano	NA	NA	NA	NA	Crew accident, arrived 5/20/96
	5/21/96	38	78	Isla Mocha	NA	NA	NA	NA	NA	Left Chilean waters
	6/28/96	30	79	Tongoy	NA	6/29/96	37	79	Concepción	
	7/5/96	36	83	Talcahuano	Callao (Peru)	7/9/96	23	80	Tocopilla	
	7/14/96	18	70	Arica	Arica	NA	NA	NA	NA	Cargo of frozen fish
	7/20/96	25	76	Taltal	Caladero	7/23/96	29	80	North of Serena	
	8/29/96	30	79	Tongoy	Fishing grounds	8/30/96	33	84	Valparaíso	
	9/9/96	30	75	Coquimbo	Coquimbo	NA	NA	NA	NA	Cargo of frozen fish
	5/16/97	37	79	Coronel	NA	5/18/96	30	77	South of Coquimbo	
	6/28/97	20	74	South of Iquique	Iquique	NA	NA	NA	NA	Tied up with the *Radoche I*
	7/6/97	18	70	Arica	Arica	NA	NA	NA	NA	Arrived at Arica 7/6/97
	7/12/97	24	77	South of Antofagasta	Fishing grounds	7/14/97	29	80	La Serena	
Radoche I										
	4/23/97	52	68	Punta Dungeness	Fishing grounds	4/28/97	41	78	Valdivia	Cargo of frozen bait
	5/31/97	37	80	Coronel	Fishing grounds	6/2/97	30	77	South of Coquimbo	Cargo of frozen fish (40 t) and bait (100 t)
	7/11/97	NA	NA	NA	Fishing grounds	7/13/97	20	74	Iquique	Entered Iquique for repairs
Rosu III										
	5/29/96	36	83	Talcahuano	Talcahuano	NA	NA	NA	NA	Goniometro repairs
	5/25/97	29	81	South of Isla Choros	Fishing grounds	5/26/97	25	76	North of Taltal	
	6/10/97	18	70	North of Arica	Arica	NA	NA	NA	NA	Arrived Arica, 6/10/97

FZ - Change
LOA - unknown
NA - Not available
Source: Chilean Navy, unpublished data.

SERIES E APPENDICES: CATCH AND LANDINGS

E1: Overall fisheries catch
E2: Overall swordfish catch
E3: Artisanal swordfish catch
E4: Commercial swordfish catch
E5: Foreign swordfish catches

Appendix E1a.--Chile and Peru. Overall fisheries catch, 1985-96

Year	Catch	
	Chile	Peru
	Million metric tons	
1985	4.8	4.1
1986	5.6	5.6
1987	4.8	4.6
1988	5.2	6.6
1989	6.5	6.9
1990	5.2	6.9
1991	6.0	6.9
1992	6.5	6.9
1993	6.0	8.5
1994	7.8	11.6
1995	7.6	8.9
1996	6.9*	NA
1997	6.5P**	NA**
1998	5.0P**	NA**

NA - Not available
P - Rough projections by the authors to show anticipated trend lines
* SERNAP reported 7.2 million t, but adjusted to conform to FAO statistical guidelines the catch would have been about 7.0 million tons.
** Officials are reporting substantial declines in the 1997 catch, but an anticipated further decline in 1998 may be even more severe.
Source: FAO, *Yearbook of Fishery Statistics*, various years (1985-95 data) and SERNAP, *Anuario Estadistíco de Pesca*, 1996 (1996 Chilean data).

Appendix E1b.--Chile. Small pelagic and overall fisheries catch, 1989-94

Year	Small pelagics				Other	Total	Proprtion small pelagic
	J. mackerel	Sardine	Anchovy	Total			
	Million metric tons						Percent
1989	2.4	1.6	1.7	5.7	0.8	6.5	88
1990	2.5	0.9	0.8	4.2	1.0	5.2	81
1991	3.0	0.7	0.9	4.6	1.4	6.0	77
1992	3.2	0.8	1.3	5.3	1.2	6.5	82
1993	3.2	0.5	1.5	5.2	0.8	6.0	83
1994	4.0	0.2	2.7	6.9	0.9	7.8	88
1995	4.4	0.3	2.1	6.8	0.8	7.6*	89
1996	3.9	0.5	1.4	5.8	1.1	6.9*	84
1997	NA**	NA	NA***	NA	NA	6.5P#	NA
1998	NA	NA	NA	NA	NA	5.0P	NA

P - Rough projections by the authors to show anticipated trend lines
NA - Not available
* Adjusted to conform to FAO statistical guidlines which do not include seaweed.
** Chilean industry sources in mid-1997 were reporting a decline in the jack mckerel catch of about 1 million t as a result of the developing El Niño.
*** Chilean anchovy catches as of mid-1987 had increased. Apparently the population shared with Peru had shifted south into Chilean waters. Chilean sources believe, however, that the 1998 catch will probably decline.
# Estimate by the authors based on discussions during mid-July with industry representatives and government officials.
Source: FAO, *Yearbook of Fishery Statistics*, various years (1989-94 data) and SERNAP, *Anuario Estadistíco de Pesca*, 1995-96 (1995-96 data).

Appendix E2a1.--Chile. Swordfish catch, 1938-96

Year	Catch	Year	Catch
	Metric tons		Metric tons
1938	641	1980	104
1939	992	1981	294
		1982	285
1940	759	1983	342
1941	483	1984	103
1942	938		
1943	1,411	1985	342
1944	NA	1986	764
		1987	2,059
1945	1,455	1988	4,455
1946	2,146	1989	5,824
1947*	1,701		
1948	1,209	1990	4,955
1949	690	1991	7.255**
		1992	6,379
1950	786	1993	4,712
1951	870	1994	3,801
1952	570		
1953	416	1995	2,594
1954	334	1996	3,145***
1955	237		
1956	386		
1957	357		
1958	392		
1959	555		
1960	455		
1961	394		
1962	297		
1963	94		
1964	312		
1965	151		
1966	175		
1967	203		
1968	175		
1969	314		
1970	243		
1971	181		
1972	141		
1973	410		
1974	218		
1975	137		
1976	13		
1977	32		
1978	56		
1979	40		

* Neighboring Peru began reporting significant catches in 1947. For details see the Peruvian chapter of this report.
** All time record
*** The catch off Chile actually declined. The 1996 increase was due to an increased commercial catch outside Chile's 200-mile zone in international waters (appendix E2b.)
Note: FAO has in recent years used the data provided by SERNAP (appendices E2a2 and E2c1).
Source: FAO, *Yearbook of Fishery Statistics*, various years; *Anuario Estadísticos de Pesca*, various years (Dirección de Pesca y Caza, Servicio Agrícola y Ganadero, and Servicio Nacional de Pesca), various years; and M. Angela Barbieri B., Eleuterio Yáñez R., Luis Ariz A., and Antonio González C., "La pesquería del pez espada: Tendedencias y perspectivas," *Perspectivas de la Actividad Pesquera en Chile* (Escuela de Ciencias del Mar, UCV: Valparaíso, 1990, p. 204.

Appendix E2a2.--Chile. Swordfish catch, 1985-96

Year	Catch	Change
	Metric tons	Percent
1985	342	232
1986	764	123
1987	2,059	170
1988	4,455	116
1989	5,824	31
1990	4,955	-15
1991	7,255*	46
1992	6,379	-12
1993	4,712	-35
1994	3,801	-19
1995	2,594	-46
1996	3,145**	+21

* All time record
** The 1996 increase is due to shifting operations away from the coast into international waters.
Source: Servicio Nacional de Pesca, *Anuario Estadístico de Pesca*, various years.

Appendix E2b.--Chile. Swordfish catch, 1990-96

Year	Catch		Total	Proportion outside EEZ*
	Chilean EEZ	Outside EEZ*		
	Metric tons			Percent
1990	4,955	-	4,955	-
1991	6,490	765	7,255	10.5
1992	5,816	563	6,379	8.8
1993	3,728	984	4,712	20.9
1994	3,208	593	3,801	15.6
1995	2,322	272	2,594	10.5
1996	871	2,274	3,145	72.3

* Almost all of this catch is taken by commercial vessels, including factory vessels. The "Outside EEZ" column is believed to be Chilean catch in the eastern Pacific, outside the Chilean 200-mile limit. A few Chilean longliners operate in the Atlantic, but that catch is not believed to be included in this total. For details see the "International" section of the Chilean or the Uruguyan chapters.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E2c1.--Chile. Total swordfish catches, by month, 1985-96

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
						Metric tons							
1984	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	103
1985	1	52	198	35	15	14	21	3	-	3	-	-	342
1986	4	44	197	178	74	106	78	82	1	-	-	-	764
1987	20	44	211	646	806	135	73	96	20	-	8	-	2,059
1988	71	275	711	1,127	1,176	577	386	122	7	2	-	1	4,455
1989	35	196	605	1,106	1,582	939	769	580	12	-	-	-	5,824
1990	9	116	565	989	1,305	1,060	204	386	188	98	11	24	4,955
1991	55	41	968	1,118	1,432	959	738	1,407	207	113	129	88	7,255
1992	9	315	387	992	1,584	1,343	1,114	267	150	147	34	37	6,379
1993	5	69	499	976	1,023	821	764	164	112	55	81	143	4,712
1994	10	21	277	624	813	658	607	443	196	91	34	27	3,801
1995	8	12	133	408	519	540	257	285	198	119	88	27	2,594
1996#	3	45	55	370	567	590	402	431	118	283	168	113	3,145
Average*													
1985-89	26	122	384	618	731	354	265	177	8	1	2	Negl	2,689
1990-94	18	112	539	940	1,231	968	685	533	171	101	58	64	5,420
1995-96	6	29	94	389	543	565	330	358	158	201	128	70	2,870

NA - Not available
Less striking seasonal pattern is due to the shift from coastal grounds into international waters.
* Monthly averages may not agree with totals due to rounding.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E2c2.--Chile. Total proportional swordfish catches, by month, 1985-96

Year	Month												Total*
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
						Metric tons							
1985-89	1	5	14	23	27	13	10	7	Negl	Negl	Negl	Negl	100
1990-94	Negl	2	10	17	23	18	13	10	3	2	1	1	100
1995-96	Negl	1	3	14	19	20	11	12	6	7	4	2	100

* Totals may not add to 100 percent due to rounding.
NA - Not available
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E2d1.--Chile. Overall seasonal fishing activity, by region, 1990-95

Region	Principal port	Latitude	Landings 1990	1991	1992	1993	1994	1995	Fleet
			Monthly landings reported						
I	Arica	18°S	Jul	Feb	Mar-May/Aug-Sep	-	Apr	-	
II	Antofagasta	24°S	Mar-Sep	Mar-May	May	Mar-May	Mar-May	Jun	
III	Caldera	27°S	Mar-Oct	Feb-Sep	Mar-Sep	Feb-Jun/Aug	Mar-May/Aug	Mar-Jun/Aug-Sep	Bongos
IV	Coquimbo	30°S	Feb-Dec	Jan-Dec	*	Jan-Apr/Jun-Dec	Jan-Dec	Jan-Nov	Longline#
V	San Antonio	33°S	Jan-Oct	Jan-Dec	Jan-Dec	Feb-Nov	Jan-Dec	Feb-Dec	
VI			-	-	Apr	-	-	-	
VII	Constitución	36°S	Jan-Jul	Feb-Aug	Feb-Aug	Mar-Aug	Mar-Aug	Mar-Jun/Aug	Drifnet
VIII	Talcahuano/Lebu	37-38°S							Drifnet
IX			-	-	-	-	-	-	
X	Valdivia	40°S	Feb-May	Jan-Apr/Jun	Mar-Jul	Mar-Jul	Mar-Jun/Aug	Mar-Apr/Jun-Jul	
XI			-	-	-	-	-	-	
XII			-	-	-	-	-	-	

Note: Relative importance of the regional landings is available in appendix E2e1.
* Jan/Mar-Apr/Jun-Dec
# Length of season in part due to the extensive commercial longline activity, which is not as seasonal as artisanal activity, from Coquimbo.
Source: Based on monthly landings data reported in SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E2d2.--Chile. Overall peak* seasonal fishing activity, by region, 1990-95

Region	Principal port	Latitude	Landings 1990	1991	1992	1993	1994	1995	Fleet
			Significant monthly landings reported*						
I	Arica	18°S	MA	MA	Apr	NA	MA	NA	
II			Apr-Jun	MA	MA	MA	MA	MA	
III	Caldera	27°S	Mar-May/Oct	Mar-Aug	Apr-May/Jul	Mar-May	Apr	Apr-May	Bongos
IV	Coquimbo	30°S	Mar-Dec	Jan/Mar-Dec	Mar-Apr/Jul-Nov	**	Mar-Dec	Mar-Sep	Longline#
V	San Antonio	33°S	Feb-Sep	Jan-Nov	Feb-Dec	Feb-Sep	Mar-Sep	Mar-Dec	
VI			-	-	MA	-	-	-	
VII	Constitución	36°S	Mar-Jul	Mar-Jun	Feb-Jun	Mar-Julu	Mar-Jul	Mar-Jun/Aug	
VIII	Talcahuano/Lebu	37-38°S							
IX			-	-	-	-	-	-	
X	Valdivia	40°S	Mar-Apr	MA	Mar-Jun	Mar-Apr	Jun-Aug	MA	
XI			-	-	-	-	-	-	
XII			-	-	-	-	-	-	

Note: Relative importance of the regional lanfings is available in appendix E2e1.
MA - Minimal activity (landings of less than 10 tons).
* Landings of 10 tons or more.
** Mar-Apr/Jun-Aug/Oct-Dec
# Length of season in part due to the extensive commercial longline activity, which is not as seasonal as artisanal activity, from Coquimbo.
Source: Based on monthly landings data reported in SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E2e1.--Chile. Total* swordfish landings, by area, 1985-96

Year	Regions													Total
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	IW	
							Metric tons							
1984	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-	103
1985	-	-	1	-	331	-	10	-	-	-	-	-	-	342
1986	-	-	-	4	735	-	25	-	-	-	-	-	-	764
1987	7	17	16	2	1,828	-	189	-	-	-	-	-	-	2,059
1988	10	105	542	38	3,037	-	477	200	-	46	-	-	-	4,455
1989	1	26	589	4	3,789	-	498	904	7	6	-	-	-	5,824
1990	2	72	149	452	3,013	-	412	769	-	86	-	-	-	4,955
1991	12	18	270	924	2,662	-	583	2,005	-	16	-	-	765	7,255
1992	28	5	77	285	3,310	1	306	1,709	-	95	-	-	563	6,379
1993	-	7	133	410	2,100	-	205	807	-	66	-	-	984	4,712
1994	4	5	29	743	1,063	-	136	1,188	-	40	-	-	593	3,801
1995	-	2	61	200	1,634	-	81	332	-	12	-	-	272	2,594
1996	-	-	49	103#	307	-	71	285	-	56	-	-	2,274	3,145
Average														
1985-89	4	30	230	10	1,944	-	240	221	1	10	-	-	-	2,689
1990-94	9	21	132	563	2,430	Negl	328	1,296	-	61	-	-	635	2,594
1995-96	-	1	55	152#	971	-	76	309	-	34	-	-	1,273	2,870

NA - Not available
IW - Caught in international waters
* All vessels: artisanal and commercial, including factory vessels.
# Current SERNAP statistics significanly understate the importance of Coquimbo. Much of the catch outside 200- miles is landed in Coquimbo, but reported as "internatiuinal waters" rather than Region IV.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E2e2.--Chile. Total* proportional swordfish landings, by area, 1984-96

Year	Regions													Total**
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	IW	
							Percent							
1985-89	Negl	1	9	Negl	72	-	9	8	Negl	Negl	-	-	-	100
1990-94	Negl	Negl	2	10	45	-	6	24	Negl	1	-	-	12#	100
1995-96	-	Negl	2	5##	34	-	3	11	-	Negl	-	-	44#	100

NA - Not available
IW - Caught in international waters
* All vessels: artisanal and commercial, including factory vessels.
** Totals may not add to 100 percent due to rounding.
# Because much of the catch beyond 200-miles is landed in Coquimbo, the authors believe that the fish was primarily caught at lattitudes northcentral or northern Chile.
Current SERNAP statistics significanly understate the importance of Coquimbo. Much of the catch outside 200- miles is landed in Coquimbo, but reported as "internatiuinal waters" rather than Region IV.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E2f.--Chile. Swordfish landings by fleet, 1985-96

Year	Fleet		Total	Proportion artisanal
	Artisanal	Commercial*		
	1,000 Metric tons			Percent
1985	0.3	-	0.3	100
1986	0.7	Negl	0.8	98
1987	1.9	0.2	2.1	90
1988	4.0	0.5	4.5	89
1989	4.7	1.1	5.8	81
1990	3.9	1.1	5.0	78
1991	3.3	4.0	7.3	45
1992	2.8	3.0	6.4	44
1993	2.7	1.9	4.7	57
1994	2.6	1.3	3.8	68
1995	2.1	0.5	2.6	81
1996	0.6	2.5**	3.1	20

* Including factory vessels operating in 1991 and 1993 (appendix E2g).
** Only 241 t of the commercial caught was taken within Chile's 200-mile zone.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E2g.--Chile. Swordfish landings by fleet, 1985-96

Year	Artisanal			Commercial				Total
	Small*	Medium*	Total	Inside EEZ	Outside EEZ	Factory***	Total	
			Metric tons					
1985	NA	NA	342	-	-	-	-	342
1986	NA	NA	747	17	-	-	17	764
1987	NA	NA	1,869	190	-	-	190	2,059
1988	NA	NA	3,972	483	-	-	483	4,455
1989	NA	NA	4,741	1,083	-	-	1,083	5,824
1990	NA	NA	3,850	1,105	-	-	1,105	4,955
1991	NA	NA	3,286	3,204	338	427	3,969	7,255
1992	NA	NA	2,801	3,015	563	-	3,578	6,379
1993	1,763	970	2,733	995	887	97	1,979	4,712
1994	1,981	571	2,552	656	593	-	1,346	3,801
1995	NA	NA	2,085	237	272	-	509	2,594
1996	NA	NA	630	241	2,274	-	2,515	3,145

NA - Not available
* Less than 12 meters
** 12 meters or more
*** Factory vessel operations are all outside the 200-mile EEZ.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E2h1.--Chile. Swordfish catch, by fishing zone*, 1994

Zone	1994							Total	Proportion
	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
				Metric tons					Percent
Artisanal fleet									
2	1.2	0.4	0.3	-				1.9	Negl
3	25.1	39.6	102.2	9.9				176.8	15
4	151.2	121.2	21.0	1.1				294.5	25
5	0.7	3.2	-	-				3.9	Negl
6	61.9	39.9	18.9	Negl				120.7	10
Total	240.1	204.3	142.4	11.0				597.8	52
Commercial fleet									
1	-	60.8	77.6	57.2	65.5	33.0	53.8	347.9	30
3	117.9	30.9	57.6	3.8	-	-	-	210.1	18
Total	117.9	91.7	135.2	61.0	65.5	33.0	53.8	558.0	48
Total**	358.0	296.0	277.6	72.0	65.5	33.0	53.8	1,155.8	100

* Zones delineated in map 3.
** Totals may not agree due to rounding.
Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones), 1994," Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 42.

Appendix E2h2.--Chile. Swordfish catch, by fishing zone*, 1995

Zone	1995							Total	Proportion
	Jan	Feb	Mar	Apr	May	Jun	Jul		
				Metric tons					Percent
Artisanal fleet									
1					5.6			5.6	1
2			7.1	14.4	11.8	12.9		46.2	5
3			7.6	24.5	38.8	50.8	28.5	150.2	15
4		0.7	9.4	49.9	35.1	51.9	54.1	201.2	21
5		0.5		6.6	17.4	18.2	6.6	49.3	5
6		5.6	53.6	80.2	69.4	84.7	7.7	301.2	31
Total		6.9	77.8	175.1	178.1	218.5	97.0	753.7	77
Commercial fleet									
1	14.6	11.6	39.2	50.1	20.9			136.5	14
3					24.1	47.2	14.6	85.8	9
Total	14.6	11.6	39.2	50.1	45.0	47.2	14.6	222.3	23
Total**	14.6	18.5	117.0	225.2	223.1	265.7	111.6	976.0	100

* Zones delineated in map 3.
** Totals may not agree due to rounding.
Source: M. Angela Barbieri Bellolio, J. Miguel Donoso Pastor, Eleuterio Yáñez Rodríguez, Antonio González Casanga, Víctor Catasti Barraza, Marcelo García Alvarado, "Monitoreo de la pesquería de recurso pez espada (I-X Regiones), 1994," Proyecto FIPA N°11/93 (IFOP: Valparaíso, November, 1995), p. 43.

Appendix E3a1.--Chile. Total artisanal swordfish landings, by month, 1985-96

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
						Metric tons							
1985	1	52	198	35	15	14	21	3	-	3	-	-	342
1986	3	38	195	178	74	106	71	81	1	-	-	-	747
1987	20	32	162	597	779	134	58	70	10	-	7	-	1,869
1988	71	246	624	1,001	1,046	480	372	122	7	2	-	1	3,972
1989	35	168	537	895	948	848	747	551	12	-	-	-	4,741
1990	4	102	499	789	975	827	152	302	129	59	-	12	3,850
1991	25	28	335	739	828	570	495	122	70	50	10	14	3,286
1992	3	13	116	501	989	794	221	74	12	45	15	18	2,801
1993	5	24	310	658	803	464	359	60	46	-	4	-	2,733
1994	-	3	170	418	558	502	369	305	111	75	14	27	2,552
1995	7	12	122	359	472	490	201	148	128	62	61	23	2,085
1996	-	1	11	147	101	206	60	31	11	60	-	2	630
													Average*
1985-89	26	107	343	541	572	316	254	165	6	1	1	Negl	2,334
1990-94	7	34	286	621	831	631	319	173	74	46	9	19	3,044
1995-96	4	7	67	253	287	348	131	90	70	61	31	13	1,358

NA - Not available
* Averages may not add to 100 percent due to rounding.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E3a2.--Chile. Proportional artisanal swordfish landings, by month, 1985-95

Year	Month												Total*
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
						Percent							
1985-89	Negl	5	15	23	25	14	11	7	Negl	Negl	Negl	Negl	100
1990-94	Negl	1	9	20	27	21	10	6	2	2	Negl	1	100
1995-96	1	1	5	19	21	26	10	7	5	4	2	1	100

* Totals may not add to 100 percent due to rounding.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E3b1.--Chile. Total artisanal swordfish landings, by area, 1985-96

Year	Regions													Total
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	IW	
								Metric tons						
1985	-	-	1	-	331	-	10	-	-	-	-	-	-	342
1986	-	-	-	4	735	-	8	-	-	-	-	-	-	747
1987	7	17	16	2	1,827	-	-	-	-	-	-	-	-	1,869
1988	10	105	542	38	3,035	-	5	200	-	37	-	-	-	3,972
1989	1	26	589	4	3,229	-	106	773	7	6	-	-	-	4,741
1990	2	72	146	246	2,764	-	-	574	-	46	-	-	-	3,850
1991	12	18	251	113	2,191	-	-	690	-	11	-	-	-	3,286
1992	21	5	71	31	1,808	1	15	840	-	9	-	-	-	2,801
1993	-	7	129	102	1,650	-	126	701	-	18	-	-	-	2,733
1994	-	5	29	474	799	-	81	1,127	-	37	-	-	-	2,552
1995	-	2	56	159	1,506	-	39	312	-	11	-	-	-	2,085
1996	-	-	37	58	192	-	25	262	-	56	-	-	-	630
														Average*
1985-89	4	30	230	10	1,831	-	26	195	1	9	-	-	-	2,334
1990-94	7	21	125	193	1,842	Negl	44	786	-	24	-	-	-	3,044
1995-96	-	1	47	109	849	-	32	287	-	34	-	-	-	1,358

IW - Caught in international waters
NA - Not available
* Monthly averages may not agree with totals due to rounding.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix D3b2.--Chile. Total proportional artisanal swordfish landings, by area, 1985-95

Year	Regions													Total*
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	IW	
							Percent							
1985-89	Negl	1	10	Negl	78	-	1	8	Negl	Negl	-	-	-	100
1990-94	Negl	1	4	6	61	Negl	1	26	-	1	-	-	-	100
1995-96	-	Negl	3	8	63	-	2	21	-	3	-	-	-	100

IW - Caught in international waters
* Totals may not add to 100 percent due to rounding.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E3c1.--Chile. Artisanal swordfish landings (medium vessels*), by month, 1993-94

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
						Metric tons							
1992	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1993	-	1	232	209	250	125	110	35	4	-	4	-	970
1994	-	-	42	94	109	108	32	146	40	-	-	-	571
1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA- Not available
* Vessels of 12 m or more
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E3c2.--Chile. Artisanal swordfish landings (medium boats*), by area, 1993-94

Year	Regions													Total
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	AL	
							Metric tons							
1992	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1993	-	-	11	31	717	-	23	181	-	7	-	-	-	970
1994	-	-	2	143	200	-	10	208	-	8	-	-	-	571
1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

AL - Caught in international waters
NA - Not available
* Boats 12 meters or more
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E3d1.--Chile. Artisanal swordfish landings (small vessels**), by month, 1992-94

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
							Metric tons						
1992	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1993	5	23	78	449	553	339	249	25	42	-	-	-	1,763
1994	-	3	128	324	449	394	337	159	71	75	14	27	1,981
1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA - Not available
** Vessels less than 12m
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E3d2.--Chile. Artisanal swordfish landings (small boats*), by area, 1993-94

Year	Regions													Total
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	IW	
							Metric tons							
1992	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1993	-	7	118	71	933	-	103	520	-	11	-	-	-	1,763
1994	-	5	27	331	599	-	71	919	-	29	-	-	-	1,981
1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

AL - Caught in international waters
NA - Not available
* Boats less than 12 meters
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E3e.--Chile. Artisanal swordfish landings, by vessel size, 1985-95

Year	Size		Total
	Small*	Medium**	
	Metric tons		
1992	NA	NA	2,801
1993	1,763	970	2,733
1994	1,981	571	2,552
1995	NA	NA	2,085

NA- Not available
* Vessels less than 12 meters.
** Vessels of 12 meters or more.
Source: SERNAP, *Anuario Estadistico de Pesca*, various years.

Appendix E4a1.--Chile. Commercial domestic swordfish landings, by month# 1985-96

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
						Metric tons							
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	1	6	2	-	-	-	7	1	-	-	-	-	17
1987	-	12	49	49	27	1	15	26	10	-	1	-	190
1988	-	29	87	126	130	97	14	-	-	-	-	-	483
1989	-	28	68	211	634	91	22	29	-	-	-	-	1,083
1990	5	14	66	200	330	233	52	84	59	39	11	12	1,105
1991	30	13	633	379	514	319	147	1,028	59	32	18	32	3,204
1992	2	289	220	443	578	461	825	67	58	52	10	10	3,015
1993	-	13	94	238	188	148	175	43	3	25	36	32	995
1994	10	4	72	84	116	90	162	65	39	-	14	-	656
1995	-	-	8	36	47	42	28	23	24	12	17	-	237
1996#	-	1	11	147	101	206	60	31	11	60	-	2	630
													Average*
1985-89	Negl	15	41	77	158	38	12	11	2	-	Negl	-	355
1990-94	9	67	217	269	345	250	272	257	44	30	18	17	1,795
1995-96	-	1	10	92	74	124	44	27	18	36	9	1	434

Note: Monthly landings within the Chilean EEZ.
The seasonal patern for the commercial fleet can vary depending on where the catch was taken. This is especially true in 1996 when so much of the catch was taken outside Chile's 200-mile zone (appendix E4b1).
* Averages may not agree with total due to rounding.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E4a2.--Chile. Proportional domestic commercial swordfish landings, by month, 1985-95

Year	Month												Total*
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
							Percent*						
1985-89	-	4	12	22	45	11	3	3	1	-	-	-	100
1990-94	1	4	12	15	19	14	15	14	2	2	1	1	100
1995-96	-	Negl	2	21	17	29	29	10	6	8	2	Negl	100

* Totals may not add to 100 percent due to rounding.
Note: Monthly catches within the Chilean EEZ.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E4b1.--Chile. Commercial swordfish landings in international waters*, by month, 1990-96

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
							Metric tons						
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	-	-	-	-	90	-	62	17	48	31	48	42	338
1992	4	13	51	48	17	88	68	126	80	50	9	9	563
1993	-	32	95	80	32	209	230	61	63	30	41	14	887
1994	-	14	35	122	139	66	76	73	46	16	6	-	593
1995	1	-	3	13	-	8	28	114	46	45	10	4	272
1996	3	42	44	146	385	331	327	395	99	223	168	111	2,274
													Average**
1991-94	1	15	45	63	70	91	109	69	59	32	26	16	595
1995-96	2	21	24	80	193	170	178	255	73	134	89	58	1,273

NA - Not available
* Believed to be international waters in the eastern Pacific.
** Averages may not agree with total due to rounding.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E4b2.--Chile. Proportional commercial swordfish landings in international waters*, by month, 1991-96

Year	Month												Total**
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
						Percent							Average
1991-94	Negl	3	8	11	12	15	18	12	10	5	4	3	100
1995-96	Negl	2	2	6	15	13	14	20	6	11	7	5	100

NA - Not available
* Believed to be international waters in the ETP
** Totals may not add to 100 percent due to rounding.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E4c.--Chile. Factory vessel swordfish landings, by month, 1991-95

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
					Metric tons								
1990	-	-	-	-	-	-	-	-	-	-	-	-	-
1991	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	232*
1992	-	-	-	-	-	70	34	240	30	-	53	-	427
1993	-	-	-	-	-	-	-	-	-	-	-	97	97
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: The factory vessel catch was all in international waters.
NA - Not available
* Almost all (231 t) processed as H&G product.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E4d1.--Chile. Domestic* commercial swordfish landings, by area, 1985-96

Year	Regions												Total
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
						Metric tons							
1985	-	-	-	-	-	-	-	-	-	-	-	-	-
1986	-	-	-	-	-	-	17	-	-	-	-	-	17
1987	-	-	-	-	1	-	189	-	-	-	-	-	190
1988	-	29	87	126	130	97	14	-	-	-	-	-	483
1989	-	-	-	-	560	-	392	131	-	-	-	-	1,083
1990	-	-	3	206	249	-	412	195	-	40	-	-	1,105
1991	-	-	19	811	471		583	1,315	-	5	-	-	3,204
1992	7	-	6	254	1,502	-	291	869	-	86	-	-	3,015
1993	-	13	94	238	188	148	175	43	3	25	36	32	995
1994	4	-	-	269	264	-	55	61	-	3	-	-	656
1995	-	-	5	41	128	-	42	20	-	1	-	-	237
1996	-	-	12	45	115	-	46	23	-	-	-	-	241
													Average**
1986-89	-	7	22	32	173	24	153	33	-	-	-	-	443
1990-94	2	3	24	356	535	30	303	497	1	32	7	6	1,795
1995-96	-	-	9	43	122	-	44	22	-	1	-	-	239

* Within Chile's 200-mile EEZ
** Monthly totals may not agree with totals due to rounding.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E4d2.--Chile. Domestic* commercial swordfish landings, by area, 1986-96

Year	Regions												Total**
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
								Percent					
1986-89	-	2	5	7	39	5	35	7	-	-	-	-	100
1990-94	-	-	1	20	30	2	17	28	Negl	2	Negl	Negl	100
1995-96	-	-	4	17	51	-	18	9	-	Negl	-	-	100

* Within Chile's 200-mile EEZ
** Totals may not add to 100 percent due to rounding.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix E5.--Latin America. Pacific swordfish catches, by area, 1980-95

Country/Area	Year															
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	Metric tons															
Eastern Central Pacific (FAO area 77)																
Costal countries																
Cook Island	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40
Fr Poly	-	-	-	-	-	-	-	11	7	7	7	7	5F	-	-	-
Mexico	380	1,575	1,365F	120	47	18	422	550	613	690	2,650**	861	1,160	806	567	424
Tonga	-	-	-	-	-	-	-	1	1	1	5	4	4	5	8	10
USA*	489	443	726	1,195	2,009	2,370	1,585	1,221	1,084	588	2,132	4,597	5,543	6,668	4,400	3,409
Subtotal	869	2,018	2,091F	1,315	2,056	2,388	2,007	1,783	1,705	1,286	4,794	5,469	6,712	7,479	4,975	3,883
Distant-water countries																
Japan	3,299	3,345	2,652	2,628	2,554	2,416	2,767	3,889	4,053	3,480	3,173	2,837	3,712	2,709	2,101	1,819
Korea	23	38	98	94	51	54	23	81	59	51	36	105	78	82	15	13
Taiwan	109F	96F	85F	131F	133F	137F	130F	150F	160F	400F	460F	190F	180F	210F	330F	870F
Subtotal	3,431	3,479	2,835	2,853	2,738	2,607	2,920	4,120	4,272	3,931	3,669	3,132	3,970	3,001	2,446	2,702
Total	4,300	5,497	4,926	4,168	4,794	4,995	4,927	5,903	5,977	5,217	8,463	8,601	10,682	10,480	7,421	6,585
Southeast Pacific (FAO area 87)																
Costal countries																
Chile	104	294	285	342	103	342	764	2,059	4,455	5,824	4,955	7,255	6,379	4,712	3,801	2,594
Colombia	-	-	-	-	-	-	-	-	-	-	-	29	-	-	-	-
Ecuador	-	-	-	-	-	-	-	-	-	-	352	350	350	33	Negl	222
Peru	216	91	154	225	298	92	33	62	129	83	2	3	21	19	5	-
Subtotal	320	385	439	567	401	434	797	2,121	4,584	5,907	5,309	7,637	6,750	4,764	3,806	2,816
Distant countries																
Japan	534	506	365	749	672	254	442	541	924	411	763	758	1,027	605	824	477
Korea	42	6	-	-	-	-	-	-	-	-	-	3	-	-	-	-
Subtotal	576	512	365	749	672	254	442	541	924	411	763	761	1,027	605	824	477
Total	896	897	804	1,316	1,073	688	1,239	2,662	5,508	6,318	6,072	8,398	7,777	5,369	4,630	3,293

* Includes some distantwater catches.
** The authors believe this
# Numbers in parenthesis indicate the number of FAO areas where swordfish operations are conducted.
F - FAO estimate
Source: FAO, *Yearbook of Fishery Statistics*, various years.

Appendix F1.--Chile. Swordfish catch and effort, by port, 1991

Port	Trips		Catch	
	Number	Duration*	Quantity	Yield**
	Number	Days	Metric tons	Kg/trip
San Antonio	965	4	497.8	724
Lebu	348	6	471.8	1,279
Constitución	431	7	392.1	929
San Vicente	149	5	212.3	1,435
Caldera	451	5	146.8	379
Valparaíso	104	5	61.4	1,096
Valdivia	8	5	2.6	869
Total/average	2,456	5	1,720.8	959

Note: This data represents only about 25 percent of the 7,255 t (live weught) catch in 1991. This data may be trunk weights, but even so it is only a part of the overall catch.
* Planned not actual duration
** Per trip (Note: It is unclear to the authors how this average was calculated.)
Source: José Donoso P. and Carlos Montenegro, "Inves. monitoreo pesqueria de albacora temporada 1991," (IFOP Nº inven: 920020), October 1992, p. 15.

Appendix F2a.--Chile. Swordfish catches, by port in north/south order, 1988#

Port	Month									Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
					Trips					
Caldera*	-	-	-	-	29	174	225	30	-	458
Quintero	-	9	123	138	-	3	4	-	-	277
Valparaíso	-	-	8	17	-	88	74	176	-	363
San Antonio	16	148	460	409	487	204	226	125	1	2,076
Constitución	4	23	100	56	14	6	-	-	-	203
San Vicente	-	-	9	31	35	20	2	-	-	97
Lebu	31	75	115	128	89	69	20	-	-	527
Valdivia**	11	7	6	-	-	-	-	-	-	24
Total	62	262	821	779	654	564	551	331	1	4,025

Year not identfied in the source, but probably is 1988.
* Northern most port
** Southern most port
Note: The fishery begins during the summer months (January-March) in the south and then shifts to the north as the fish move to warmer water during the winter months (July-September).
Source: IFOP, "Recurso albacora," *Estudio Biológico Pesquero* (Nº inven: 900016) IFOP, May 1990, p. 8.

Appendix F2b.--Chile. Swordfish catches, by port in order of importance, 1988#

Port	Month									Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
					Trips					
San Antonio	16	148	460	409	487	204	226	125	1	2,076
Lebu	31	75	115	128	89	69	20	-	-	527
Caldera	-	-	-	-	29	174	225	30	-	458
Valparaíso	-	-	8	17	-	88	74	176	-	363
Quintero	-	9	123	138	-	3	4	-	-	277
Constitución	4	23	100	56	14	6	-	-	-	203
San Vicente	-	-	9	31	35	20	2	-	-	97
Valdivia	11	7	6	-	-	-	-	-	-	24
Total	62	262	821	779	654	564	551	331	1	4,025

Year not identfied in the source, but probably is 1988.
Source: IFOP, "Recurso albacora," *Estudio Biológico Pesquero* (Nº inven: 900016) IFOP, May 1990, p.8

Appendix F3.--Chile. Swordfish catch and effort, by port, 1991

Port	Catch	Effort	Yield**
	Metric ton	Days*	Kg/days*
Caldera	146.9	1,992	73.3
Valparaíso	61.4	416	147.5
San Antonio	497.8	3,682	135.2
Constitución	392.0	2,855	137.3
San Vicente	212.3	808	262.8
Lebu	471.8	1,666	283.2
Valdivia	2.6	31	84.1

* Days out of port
** Catch divided by the number of days out of port. As reported in source indicated below. Minor statistical iregularities in the yield are unexplained.
Source: José Donoso P. and Carlos Montenegro, "Inves. monitoreo pesqueria de albacora temporada 1991," (IFOP Nº inven: 920020), October 1992, p. 22.

Appendix F4.--Chile. Importance of Region VIII ports, swordfish landings, 1987-96

Year	Port					Total
	Coronel	Lebu	S. Vicente	Talcahuano	Tome	
			Metric ton			
1987	-	-	-	-	-	-*
1988	80	-	79	41	-	200
1989	383	-	358	163	-	904
1990	222	-	356	191	-	769
1991	156	-	300	1,526	23	2,005
1992	602	-	721	386	-	1,709
1993	363	-	152	292	-	807
1994	564	-	68	556	-	1,188
1995	74	112	64	82	-	332
1996	1	204	70	10	-	285

* Presumably small quantities of swordfish were landed in 1987 and previous years, but included under unclassified fish.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

SERIES G APPENCIES: PROCESSING/PRODUCTION

G1: Overall processing
G2: Swordfish: Utilization of raw material
G3: Swordfish: Processed product
G4: Prices

Appendix G1a.--Chile. Overall utilization of landings, 1986-96

Year	Edible	Reduction* production	Total**	Proportion edible
	Million metric tons***			Percent
1986	0.3	5.1	5.4	5.6
1987	0.4	4.3	4.7	8.5
1988	0.5	4.6	5.1	9.8
1989	0.5	5.8	6.3	7.9
1990	0.6	4.4	5.0	12.0
1991	0.6	5.3	5.9	10.2
1992	0.6	5.6	6.2	9.7
1993	0.5	5.2	5.7	8.8
1994	0.8	6.9#	7.7#	10.4
1995	1.0#	6.7	7.7#	13.0
1996	1.0#	6.0	7.0	14.3#

* Fishmeal and oil
** Totals may not agree due to rounding.
*** Live weight
# Records
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G1b.--Chile. Overall processing of finfish, 1978-96

Year	Product form					Total
	Fresh	Frozen	Canned	Dried	Smoked	
	Metric tons*					
1978	-	8,746	20,263	38	27	29,074
1979	-	14,463	25,164	9	28	39,664
1980	-	8,496	34,658	129	32	43,315
1981	-	10,667	26,649	11	34	37,361
1982	-	53,759	21,867	6	29	75,661
1983	-	41,945	38,163	2	43	80,153
1984	-	39,886	45,431	13	34	85,364
1985	1,036	38,995	40,503	238	76	80,799
1986	2,221	47,235	56,943	720	89	107,208
1987	3,309	58,428	60,362	1,291	84	123,474
1988	6,232	79,799	63,005	2,888	129	152,053
1989	8,893	83,038	75,075	2,825	205	170,036
1990	15,442	104,814	69,151	2,716	422	192,545
1991	18,674	104,173	51,735	1,950	240	176,772
1992	18,575	133,750	63,541	843	200	216,909
1993	17,653	129,214	60,387	2,989#	427	210,670
1994	22,261	141,848	80,857#	2,980	502	248,448
1995	37,103	160,030	73,893	1,425	1,030#	273,481
1996	74,890#	165,734#	67,992	477	816	309,909#

Note: Some minor categories not included.
* Product weight
# Record
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G1c.--Chile. Fresh processing, by major species, 1985-96

Year	Species				Total	Proportion swordfish
	Swordfish	A. salmon*	S. hake**	Other		
	Metric tons***					Percent
1985	49	-	332	655	1,036	4.7
1986	291	-	603	1,327	2,221	13.1
1987	768	-	1,494	1,047	3,309	23.2#
1988	1,164	54	2,991	2,023	6,232	18.7
1989	1,915	1,407	3,850	1,721	8,893	21.5
1990	2,253	5,346	4,838	3,005	15,442	14.6
1991	2,724	7,480	5,294	3,176	18,674	14.6
1992	2,817#	8,340	5,103	3,139	18,575	15.2
1993	1,993	10,100	3,428	2,132	17,653	11.3
1994	1,809	14,405	3,626	2,409	22,261	8.1
1995	1,917	27,019	4,884	3,283#	37,103	5.2
1996	1,436	43,479#	7,045#	22,930#****	74,890	1.9

* Atlantic salmon
** Southern hake (*Merlucius australis*)
*** Product weight
**** Jack mackerel, sardine, and trout appeared in large quantities for the first time in this category.
# Record
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G1d.--Chile. Processing plants, 1988-96

Year	Plants	
	Fresh	Frozen
	Number	
1988	63	221
1989	61	240
1990	92*	243
1991	106	267
1992	127	272
1993	138	279#
1994	148	268
1995	176	262
1996	196#	268

* Expanding swordfish and groundfish catches explain part of the substantial increase in the number of plants handling fresh fish, but the principal reason has been the massive development of the salmon and trout industry.
# Record
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G2a.--Chile. Total swordfish production by processing line, 1985-96

Year	Line				Total	Proportion fresh
	Fresh	Frozen	Cured	Canned		
		Metric tons*				Percent
1985	85	96	-	-	181	47
1986	353	205	-	-	558	63
1987	913	932	-	-	1,845	49
1988	1,788	2,187	-	-	3,975	45
1989	2,527	2,582	-	-	5,109	49
1990	2,829	1,843	-	3	4,675	61
1991	3,452	2,286	1	-	5,739	60
1992	3,549	1,772	8	-	5,329	68
1993	2,455	1,251	-	-	3,706	66
1994	2,413	938	-	-	3,351	72
1995	2,262	124	1	-	2,387	94
1996	2,625	484	2	-	3,111	82

* Raw material
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G2b1--Chile. Swordfish production by processing line, Region I, 1985-96

Year	Line			Total
	Fresh	Frozen	Cured	
		Metric tons*		
1985	NA	NA	NA	NA
1986	-	-	-	-
1987	-	-	-	-
1988	-	-	-	-
1989	-	-	-	-
1990	-	-	-	-
1991	-	-	-	-
1992	-	12**	-	12
1993	-	-	-	-
1994	-	1**	-	1*
1995	-	-	-	-
1996	-	-	-	-

* Raw material
** Arica
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G2b2--Chile. Swordfish production by processing line, Region II, 1985-96

Year	Line			Total
	Fresh	Frozen	Cured	
		Metric tons*		
1985	NA	NA	NA	NA
1986	-	-	-	-
1987	-	12**	-	12**
1988	-	17**	-	17**
1989	-	18**	-	18**
1990	-	22**	-	22**
1991	-	4**	-	4**
1992	-	5**	-	5**
1993	-	14**	-	14**
1994	-	14**	-	14**
1995	-	-	-	-
1996	-	-	-	-

* Raw material
** Antofagasta
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G2b3--Chile. Swordfish production by processing line, Region III, 1985-96

Year	Line			Total
	Fresh	Frozen	Cured	
		Metric tons*		
1985	NA	NA	NA	NA
1986	-	-	-	-
1987	-	-	-	-
1988	-	15	-	15
1989	-	72	-	72
1990	-	32	-	32
1991	-	13	-	13
1992	-	18	-	18
1993	-	-	-	-
1994	-	1	-	1
1995	-	-	-	-
1996	-	-	-	-

Note: The principal port in Region III is Caldera.
* Raw material
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G2b4--Chile. Swordfish production by processing line, Region IV, 1985-96

Year	Line			Total
	Fresh	Frozen	Cured	
	Metric tons*			
1985	NA	NA	NA	NA
1986	-	-	-	-
1987	-	-	-	-
1988	-	-	-	-
1989	-	-	-	-
1990	-	-	-	-
1991	-	-	-	-
1992	-	5	-	5
1993	-	2	-	2
1994	171	9	-	180
1995	223	3	-	226
1996	295	11	-	306

Note: Virtually all of the swordfish activity is commercial longliners working out of Coquimbo.
* Raw material
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G2b5--Chile. Swordfish production by processing line, Region V, 1985-96

Year	Line			Total
	Fresh	Frozen	Cured	
	Metric tons*			
1985	NA	NA	NA	NA
1986	137	182	-	319
1987	363**	831**	-	1,194**
1988	900**	1,562**	-	2,462**
1989	921***	1,908**	-	2,829**
1990	1,431***	1,184**	-	2,615**
1991	1,431***	1,423**	-	2,854**
1992	1,393***	1,043**	-	2,436**
1993	889***	1,122***	-	2,011***
1994	1,126**	846**	-	1,972**
1995	682**	64**	-	746**
1996	561**	59****	-	620**

* Raw material
** Mostly San Antonio
*** All San Antonio
**** Valparaíso and San Antonio
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G2b6--Chile. Swordfish production by processing line, Region VII, 1985-96

Year	Line			Total
	Fresh	Frozen	Cured	
	Metric tons*			
1985	NA	NA	NA	NA
1986	-	-	-	-
1987	-	-	-	-
1988	16	45	-	61
1989	-	-	-	-
1990	-	-	-	-
1991	-	-	-	-
1992	-	-	-	-
1993	-	4	-	4
1994	-	-	-	-
1995	-	-	-	-
1996	-	-	-	-

* Raw material
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G2b7--Chile. Swordfish production by processing line, Region VIII, 1985-96

Year	Line			Total
	Fresh	Frozen	Cured	
	Metric tons*			
1985	NA	NA	NA	NA
1986	-	-	-	-
1987	-	-	-	-
1988	36**	125***	-	161**
1989	164**	287***	-	451**
1990	30**	404**	-	434**
1991	73***	173**	-	246**
1992	162***	332***	-	494***
1993	272***	91***	-	363***
1994	280***	-	-	280***
1995	186***	3**	-	189**
1996	119**	67**	-	186

* Raw material
** Mostly Talcahuano
*** All Talcahuano
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G2b8--Chile. Swordfish production by processing line, Region X, 1985-96

Year	Line			Total
	Fresh	Frozen	Cured	
		Metric tons*		
1985	NA	NA	NA	NA
1986	-	-	-	-
1987	-	-	-	-
1988	-	-	-	-
1989	-	-	-	-
1990	-	-	-	-
1991	28**	1***	-	29**
1992	10***	11**	-	21**
1993	10***	1***	-	11***
1994	-	-	-	-
1995	5***	-	1#	6***
1996	11***	49***	2#	62

* Raw material
** Mostly Valdivia
*** All Valdivia
# The smoked swordfish being cured in Region X is probably due to the increasing familariaty of companies in Puert Montt with smoking as a result of their work with salmon.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years

Appendix G2b9--Chile. Swordfish production by processing line, Region Metropolitan Santaiago, 1985-96

Year	Line				Total
	Fresh	Frozen	Cured	Canned	
		Metric tons*			
1985	NA	NA	NA	-	NA
1986	216	23	-	-	239
1987	550	89	-	-	639
1988	836	423	-	-	1,259
1989	1,439	297	-	-	1,736
1990	1,368	201	-	3	1,572
1991	1,920	671	1	-	2,592
1992	1,983	346	8	-	2,337
1993	1,284	17	-	-	1,301
1994	836	67	-	-	903
1995	1,166	54	-	-	1,220
1996	1,639	298	-	-	1,937

* Raw material
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G2c.--Chile. Monthly swordfish production, by processing line, 1985-96

Year/ line	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	Metric tons*												
1985													
Fresh	-	8	47	17	4	-	8	1	-	-	-	-	85
Frozen	1	12	45	14	7	8	8	1	-	-	-	-	96
Total	1	20	92	31	11	8	16	2	-	-	-	-	181
1986													
Fresh	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Frozen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1987													
Fresh	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Frozen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1988													
Fresh	32	74	165	522	442	371	123	58	1	-	-	-	1,788
Frozen	39	135	361	593	628	178	195	55	3	-	-	-	2,187
Total	71	209	526	1,115	1,070	549	318	113	4	-	-	-	3,975
1989													
Fresh	11	110	226	465	704	469	390	152	-	-	-	-	2,527
Frozen	17	78	400	625	468	471	197	314	12	-	-	-	2,582
Total	28	188	626	1,090	1,172	940	587	466	12	-	-	-	5,109
1990													
Fresh	4	70	341	663	794	538	119	188	71	34	-	-	2,829
Frozen	3	37	197	320	491	501	66	138	52	33	-	5	1,843
Canned	-	-	1	-	-	-	1	-	-	3	-	-	3
Total	7	107	539	983	1,285	1,039	186	326	123	68	-	12	4,675
1991													
Fresh	8	34	367	654	757	512	314	425	258	75	21	27	3,452
Frozen	17	13	246	440	516	410	177	207	99	48	6	107	2,286
Total	25	47	613	1,094	1,273	922	491	632	357	123	27	134	5,738
1992													
Fresh	4	15	262	627	943	857	522	247	57	12	3	-	3,549
Frozen	-	6	175	258	505	338	72	180	113	73	24	28	1,772
Cured	-	-	-	-	-	-	-	-	4	4	-	-	8
Total	4	21	437	885	1,448	1,195	594	427	174	89	27	28	5,329

1993													
Fresh	5	14	219	597	777	513	282	24	7	-	6	11	2,455
Frozen	-	17	34	110	331	165	369	78	73	25	21	28	1,251
Total	5	31	253	707	1,108	678	651	102	80	25	27	39	3,706
1994													
Fresh	3	10	181	431	551	537	313	235	67	32	12	41	2,413
Frozen	7	-	61	56	233	83	214	127	90	43	16	8	938
Total	10	10	242	487	784	620	527	362	157	75	28	49	3,351
1995													
Fresh	6	12	118	372	436	477	246	238	186	89	55	27	2,262
Frozen	2	-	14	36	35	10	8	1	10	-	6	2	124
Cured	-	-	-	-	-	-	-	-	-	-	-	1	1
Total	8	12	132	408	471	487	254	239	196	89	61	30	2,387
1996													
Fresh	-	30	34	313	440	519	402	360	105	216	154	52	2,625
Frozen	2	15	21	57	128	73	2	71	13	27	14	61	484
Cured	2	-	-	-	-	-	-	-	-	-	-	-	2
Total	2	45	55	370	568	592	404	431	118	243	268	113	3,111

NA- Not available
* Raw material
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G3a.--Chile. Swordfish production,* 1976-96

Year	Commodity			Total	Proportion fresh
	Fresh	Frozen	Cured		
		Metric tons*			
1975	NA	NA	NA	NA	NA
1976	NA	-	-	NA	NA
1977	-	-	-	-	-
1978	-	-	-	-	-
1979	-	-	-	-	-
1980	-	-	-	-	-
1981	-	2	-	2	-
1982	-	1	-	1	-
1983	-	-	-	-	-
1984	-	33	-	33	-
1985	49	73	-	122	40
1986	291	171	-	462	63
1987	768	752	-	1,520	51
1988	1,164	1,452	-	2,616	44
1989	1,915	1,901	-	3,816	50
1990	2,253	1,461	-	3,714	61
1991	2,724	2,170**	1	4,895	56
1992	2,817	1,496	6	4,319	65
1993	1,993	1,177	-	3,170	63
1994	1,809	822	-	2,631	69
1995	1,917	156	-	2,073	92
1996	1,436	295	1	1,732	83

NA - Not available
* Product weight
** Variously reported as 1,938 tons.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G3b1.--Chile. Swordfish production by processing line, Region I, 1992-96

Year	Line			Total
	Fresh	Frozen	Cured	
		Metric tons*		
1991	NA	NA	NA	NA
1992	-	10**	-	10**
1993	-	-	-	-
1994	-	1**	-	-
1995	-	-	-	-
1996	-	-	-	-

* Product weight
** Arica
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G3b2.--Chile. Swordfish production by processing line, Region II, 1992-96

Year	Line			Total
	Fresh	Frozen	Cured	
		Metric tons*		
1991	NA	NA	NA	NA
1992	-	3	-	5
1993	-	11**	-	11**
1994	-	11**	-	11**
1995	-	-	-	-
1996	-	-	-	

* Product weight
** Antofagasta
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G3b3.--Chile. Swordfish production by processing line, Region III, 1992-96

Year	Line			Total
	Fresh	Frozen	Cured	
		Metric tons*		
1991	NA	NA	NA	NA
1992	-	13	-	18
1993	-	-	-	-
1994	-	1	-	1
1995	-	-	-	-
1996	-	-	-	-

* Raw material
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G3b4.--Chile. Swordfish production by processing line, Region IV, 1992-96

Year	Line			Total
	Fresh	Frozen	Cured	
	Metric tons*			
1991	NA	NA	NA	NA
1992	-	4	-	4
1993	-	2	-	2
1994	138	7	-	145
1995	216	3	-	219
1996	173	7	-	180

Note: Primarily Coquimbo
NA - Not available
* Product weight
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G3b5.--Chile. Swordfish production by processing line, Region V, 1992-96

Year	Line			Total
	Fresh	Frozen	Cured	
	Metric tons*			
1991	NA	NA	NA	NA
1991	1,078***	891**	-	1,969**
1992	708***	1,067***	-	1,775***
1994	859**	756**	-	1,615**
1995	582**	51**	-	633**
1996	299**	29****	-	328

NA - Not available
* Product weight
** Mostly San Antonio
*** All San Antonio
**** Mostly Valparaíso
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G3b6.--Chile. Swordfish production by processing line, Region VIII, 1992-96

Year	Line			Total
	Fresh	Frozen	Cured	
	Metric tons*			
1991	NA	NA	NA	NA
1992	120***	252***	-	372***
1993	215**	73**	-	288**
1994	221**	-	-	221**
1995	154***	3**	-	157**
1996	64**	38**		102

NA - Not available
* Product weight
** Mostly Talcahuano
*** All Talcahuano
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G3b7.--Chile. Swordfish production by processing line, Region X, 1992-96

Year	Line			Total
	Fresh	Frozen	Cured	
	Metric tons*			
1991	NA	NA	NA	NA
1992	8***	8**	-	16**
1993	8***	1***		9***
1994	-	-	-	-
1995	4***	-	-	4***
1996	6***	38***	1****	45**

NA - Not available
* Product weight
** Mostly Valdivia
*** All Valdivia
**** All Puert Montt
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G3b8.--Chile. Swordfish production by processing line, Region Metropolitan Santaiago, 1992-96

Year	Line			Total
	Fresh	Frozen	Cured	
	Metric tons*			
1991	NA	NA	NA	NA
1992	1,611	315	6	1,932
1993	1,062	21	-	1,083
1994	591	46	-	637
1995	961	99	-	1,060
1996	894	183	-	1,077

NA - Not available
* Product weight
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G3c.--Chile. Monthly swordfish production, by processing line, 1985-96

Year/ line	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
				Metric tons*									
1987													
Fresh	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	768
Frozen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	752
Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,520
1988													
Fresh	26	54	136	325	266	239	79	38	1	-	-	-	1,164
Frozen	28	110	297	372	375	103	129	36	2	-	-	-	1,452
Total	54	164	433	697	641	342	208	74	3	-	-	-	2,616
1989													
Fresh	8	73	147	367	543	347	314	116	-	-	-	-	1,915
Frozen	11	51	264	454	370	355	150	235	11	-	-	-	1,901
Total	19	124	411	821	913	702	464	351	11	-	-	-	3,816
1990													
Fresh	2	55	266	524	637	439	98	144	55	27	-	6	2,253
Frozen	3	30	159	251	393	393	54	103	43	28	-	4	1,461
Total	5	85	425	775	1,030	832	152	247	98	55	-	10	3,714
1991													
Fresh	8	27	293	506	588	408	250	337	210	59	17	21	2,724
Frozen	15	10	194	381	430	342	157	187	87	41	6	88	1,938**
Cured	-	-	-	-	-	-	-	-	-	-	-	1	1
Total	23	37	487	887	1,018	750	407	524	297	100	23	110	4,663
1992													
Fresh	3	10	207	492	752	672	421	203	44	11	2	-	2,817
Frozen	-	6	152	223	423	301	57	144	86	57	22	25	1,496
Cured	-	-	-	-	-	-	-	-	3	3	-	-6	6
Total	3	16	359	715	1,175	973	478	347	133	71	24	25	4,319
1993													
Fresh	5	11	170	485	624	424	232	20	7	-	5	10	1,993
Frozen	-	12	27	94	323	139	323	64	59	20	16	100	1,177
Total	5	23	197	579	947	563	555	84	66	20	21	110	3,170
1994													
Fresh	3	6	148	350	451	421	206	136	31	18	11	28	1,809
Frozen	5	-	52	60	163	103	226	101	64	31	12	5	822
Total	8	6	200	410	614	524	432	237	95	49	23	33	2,631

1995													
Fresh	9	10	97	299	349	428	210	205	161	79	47	23	1,917
Frozen	2	59	10	26	31	8	5	1	9	-	3	2	156
Total	11	69	107	325	480	436	215	206	170	79	50	25	2,073
1996													
Fresh	-	15	30	177	260	274	213	184	55	115	84	29	1,436
Frozen	-	-	-	7	29	-	-	38	-	38	-	183	295
Cured	1	-	-	-	-	-	-	-	-	-	-	-	1
Total	1	15	30	184	289	274	213	222	55	153	84	212	1,732

* Product weight
** Variously reported as 2,170.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G3d.--Chile. Swordfish production, by region, 1986-96

Year/ line	Regions I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	MR	Total
							Metric tons*							
1985														
Fresh	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	49
Frozen	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	73
Total	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	122
1986														
Fresh	-	-	-	-	109	-	-	-	-	-	-	-	182	291
Frozen	-	-	-	-	155	-	-	-	2	-	-	-	16	171
Total	-	-	-	-	264	-	-	-	-	-	-	-	198	462
1987														
Fresh	-	-	-	-	315	-	-	-	-	-	-	-	453	768
Frozen	-	10	-	-	671	-	-	-	-	-	-	-	71	752
Total	-	10	-	-	986	-	-	-	-	-	-	-	524	1,520
1988														
Fresh	-	-	-	-	573	-	10	23	-	-	-	-	558	1,164
Frozen	-	14	10	-	1,043	-	30	88	-	-	-	-	267	1,452
Total	-	14	10	-	1,616	-	40	111	-	-	-	-	825	2,616
1989														
Fresh	-	-	-	-	699	-	2	119	-	-	-	-	1,095	1,915
Frozen	-	13	55	-	1,401	-	-	210	-	-	-	-	222	1,901
Total	-	13	55	-	2,100	-	2	329	-	-	-	-	1,317	3,816
1990														
Fresh	-	-	-	-	1,118	-	-	23	-	-	-	-	1,112	2,253
Frozen	-	15	24	-	948	-	-	305	-	-	-	-	169	1,461
Total	-	15	24	-	2,066	-	-	328	-	-	-	-	1,281	3,714
1991														
Fresh	-	-	-	-	1,124	-	-	55	-	21	-	-	1,524	2,724
Frozen	-	3	12	-	1,222	-	-	137	-	-	-	-	564	1,938**
Total	-	3	12	-	2,346	-	-	192	-	21	-	-	2,088	4,662
1992														
Fresh	-	-	-	-	1,078	-	-	120	-	8	-	-	1,611	2,817
Frozen	10	3	13	4	891	-	-	252	-	8	-	-	315	1,496
Cured	-	-	-	-	-	-	-	-	-	-	-	-	6	6
Total	10	3	13	4	1,969	-	-	372	-	16	-	-	1,932	4,319

1993														
Fresh	-	-	-	-	708	-	-	215	-	8	-	-	1,062	1,993
Frozen	-	11	-	2	1,067	-	2	73	-	1	-	-	21	1,117
Total	-	11	-	2	1,775	-	2	288	-	9	-	-	1,083	3,170
1994														
Fresh	-	-	-	138	859	-	-	221	-	-	-	-	591	1,809
Frozen	1	11	1	7	756	-	-	-	-	-	-	-	46	822
Total	1	11	1	145	1,615	-	-	221	-	-	-	-	637	2,631
1995														
Fresh	-	-	-	216	582	-	-	154	-	4	-	-	961	1,917
Frozen	-	-	-	3	51	-	-	103	-	-	-	-	99	156
Total	-	-	-	219	633	-	-	157	-	4	-	-	1,060	2,073
1996														
Fresh	-	-	-	173	299	-	-	64	-	6	-	-	894	1,436
Frozen	-	-	-	7	29	-	-	38	-	38	-	-	183	295
Frozen	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Total	-	-	-	180	328	-	-	102	-	44	-	-	1,077	1,732

MR - Metropolitan (Santiago) Region
NA - Not available
* Product weight
** Variously reported as 2,170 tons.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years.

Appendix G4a--Chile. Nominal prices, 1985-94

Year	Prices		Difference	
	Fresh	Frozen	Absolute	Proportional
	U.S.$/kg		US$	Percent
1985	NA	4.64	NA	NA
1986	5.47*	NA	NA	NA
1987	6.95*	NA	NA	NA
1988	6.92*	NA	NA	NA
1989	6.18	5.52	-0.66	-11
1990	5.47	4.72	-0.75	-14
1991	6.79	5.79	-1.00	-15
1992	7.51	7.79	+0.28	+ 4
1993	7.87	6.46	-1.41	-18
1994	7.49	5.83	-1.66	-22
1995	8.61	5.54	-3.07	-36
1996	8.82	6.11	-2.71	-31

NA - Not available
Note: Nomimal prices derived from U.S. imports are shown in appendix J3a1. There are substantial differences, but show similar trends.
* Separate fresh/frozen data unavailable, the nominal prices for 1986-87 include both fresh and frozen product combined. The price is closer to fresh prices as most of the exports were shipped fresh.
Source: Appendix J2h1.

Appendix G4b.--Chile. Approximate swordfish export prices, 1995

Month	Commodity	
	Fresh	Frozen
	US$1,000/metric ton	
January	8.00	7.25
February	6.50	NA
March	9.75	4.70
April	9.95	5.75
May	9.00	3.65
June	8.25	7.90

Note: Data entries are rough approximations
Source: IFOP, *Boletin Informativo SIM*, No. 32, September 1995.

Appendix H1a.--Chile. Major swordfish exporters, 1995-96

Commodity/ Company	Quantity 1995	Quantity 1996	Value 1995	Value 1996
	Metric tons		US$1,000	
Fresh				
Imp. y Exp. Nanaimo	378	612	3,693	5,858
Empacadora del Pacífico	480	289	4,155	2,474
Unidentified (96725340)*	39	176	351	1,693
Unidentified (96560790)*	91	157	854	1,438
Pesquera Isla del Rey	114	136	1,134	1,383
Pesquera Omega	180	181	1,125	1,080
Atunmar	90	152	572	1,063
Pesquera Marazul	84	62	947	642
Comercial Ocean Star	96	62	878	499
Pesquera Iquique	17	47	163	488
Pesquera Catalina	255	40	2,081	335
Others	475	72	3,838	607
Subtotal, fresh#	2,298	1,984	19,790	17,540
Frozen				
Pesquera Omega	165	153	735	689
Empacadora del Pacífico	8	44	64	315
Andes Sur	19	21	206	229
BCA Comercial	15	29	111	214
Chisal	Negl	2	4	41
Pesquera Catalina	-	6	-	31
Pesquera Isla del Rey	2	2	14	16
Unidentified (96580790)*	3	2	24	16
Arirang Chile**	-	2	-	10
Imp. y Exp. Nanaimo	1	1	3	5
Unidentified (84871700)*	-	Negl	-	2
Omega Seafoods	38	-	235	-
Pesquera Marazul	7	-	33	-
Prod. y Comer. del Mar	10	-	31	-
Elab. y Comer. de Alimentos	2	-	25	-
Unidentified (96725340)	Negl	-	1	-
Juan Arturo Urrutia Aburla	Negl	-	Negl	-
Subtotal, frozen#	269	262	1,485	1,567
Smoked				
De Veer Berti Vincent Eckart	Negl	-	Negl	-
Total#	2,567	2,245	21,275	19,107

Totals may disagree due to rounding.
The authors worked from a FAXed copy and there may be some errors as some of the characters were indistinct. These two columns do not add.
* Name of company unavailable, only the corporate registration number.
** Presumably a Korean joint venture or a company with Korean connections.
Source: Maria Isabel Ortego M, Investigador, Departamento Economia Pesquera, Instituto de Fomento Pesquero, unpublished data, August 23, 1997.

Appendix H1b.--Chile. Major swordfish exporters, 1994-96

Product form/ exporter	Proportion of value		
	1994	1995	1996
		Percent	
Fresh			
Importadora y Exportadora Nanaimo	NA	19	33
Empacadora del Pacifico	18	21	14
Unidentified (96725340)*	NA	2	10
Unidentified (96560790)*	NA	4	8
Pesquera Isla de Rey	NA	6	8
Pesquera Omega	NA	6	6
Atunamar	NA	3	6
Pesquera Catlaina	NA	11	Negl
Pesquera Grimar	11	NA	-
Empacadora Montemar	18	NA	-
Frozen			
Pesquera Omega	NA	50	43
Empacadora del Pacífico	NA	4	20
Andes Sur	8	14	15
BCA Comercial	3	7	14
Chisal	NA	2	3
Pesquera Catalina	NA	-	2
Omega Seafoods	NA	16	-
Pesquera Marazul	82	2	-
Cured			
De Veer Berti Vincent Eckart	NA	100	-

Negl - Negligible
Source: IFOP, *Boletin Informativo, SIM.* Nº. 30, February 1995 and No. 34, March 1996 and Maria Isabel Ortego M, Investigador, Departamento Economia Pesquera, Instituto de Fomento Pesquero, unpublished data, August 23, 1997.

Appendix H2.--Chile. Swordfish exports, by commodity, importing country, and exporting company, January-June, 1994 and 1995.

Commodity/country/ company	Quantity					Value				
	Jan-Jun'94		Jan-Jun'95		Difference	Jan-Jun'94		Jan-Jun'95		Difference
	Quantity	Share	Quantity	Share		Quantity	Share	Quantity	Share	
	M. tons	Percent	M. tons	Percent	Percent	M. tons	Percent	M. tons	Percent	Percent
Fresh										
United States										
Empacadora del Pacífico Ltda.	228.5	13.5	248.3	20.1	8.7	1,984.1	15.4	2,181.1	20.0	9.9
Importadora y Exportadora Nanaimo	102.8	6.1	185.1	15.0	80.1	861.0	6.7	1,792.1	16.5	108.1
Pesquera Catalina Ltda.	150.9	8.9	155.9	12.6	3.3	1,340.9	10.4	1,291.4	11.9	-3.7
Comercial Cedex Ltda.	-	-	79.1	6.4	-	-	-	764.4	7.0	-
Pesquera Grimar S.A.	239.6	14.1	83.4	6.8	-65.2	2,109.3	16.4	763.4	7.0	-63.8
Pesquera Marazul Ltda.	69.9	4.1	74.1	6.0	6.0	650.9	5.1	747.9	6.9	0.6
Pesquera Isla del Rey S.A.	1.9	0.1	61.4	5.0	3,106.4	15.1	0.1	647.0	5.9	4,176.1
Com. Proces. Envas. Prod. del Mar	2.0	0.1	89.7	7.3	4,336.2	16.5	0.1	637.7	5.9	3,771.7
Comercial Ocean Star Ltda.	28.8	1.7	61.0	4.9	111.9	231.5	1.8	593.4	5.4	156.3
Pesquera Omega Ltda.	113.4	6.7	78.4	6.3	-30.9	650.4	5.1	494.0	4.5	-24.0
Atunmar S.A.	9.9	0.6	42.5	3.4	327.5	75.7	0.6	311.4	2.9	311.5
Comercial Cisandina Chile S.A.	-	-	19.7	1.6	-	-	-	173.6	1.6	-
96560790-	-	-	18.0	1.5	-	-	-	167.4	1.5	-
Pesquera Iquique S.A.	-	-	10.2	0.8	-	-	-	91.7	0.8	-
96532480-	-	-	5.9	0.5	-	-	-	51.7	0.5	-
6165781-	-	-	4.9	0.4	-	-	-	48.4	0.4	-
7419762-	-	-	2.5	0.2	-	-	-	25.8	0.2	-
Empacadora Montemar S.A.	420.0	23.7	5.4	0.4	-98.7	1,897.0	14.8	24.2	0.2	-98.7
79955360-	-	-	1.7	0.1	-	-	-	14.8	0.1	-
Pesquera del Estrecho S.A.	-	-	1.3	0.1	-	-	-	14.1	0.1	-
Soc. Elaboradora y Comercial de PR	-	-	1.4	0.1	-	-	-	12.7	0.1	-
Indo López Raul Gabriel	-	-	1.1	0.1	-	-	-	11.0	0.1	-
Musalem Musalem Maria Soledad	1.8	0.1	1.2	0.1	-33.5	12.8	0.1	8.3	0.1	-35.3
Pesca Chile S.A.	-	-	0.7	0.1	-	-	-	5.8	0.1	-
78584690-	-	-	0.5	0.0	-	-	-	5.7	0.1	-
Comercial Mehuin Ltda.	-	-	0.6	0.0	-	-	-	5.0	0.0	-
Abastecedores Internacionales Soc.	-	-	0.6	0.0	-	-	-	3.6	0.0	-
Naviera Maq. e Inversiones S.A.	-	-	0.3	0.0	-	-	-	1.7	0.0	-
Mauricio Urruticoechea Dominguez	-	-	0.2	0.0	-	-	-	1.3	0.0	-
Costa Este Chile S.A.	114.5	6.7	0.1	0.0	-99.9	912.8	7.1	0.7	0.0	-99.9
Granja Marina Tornagaleones Ltda.	134.0	7.9	-	-	-	1,188.5	9.3	-	-	-
Soc. Comercial SBS Ltda.	75.9	4.5	-	-	-	722.9	5.6	-	-	-
Pesquera Santa Teresa S.A.	11.4	0.7	-	-	-	96.6	0.8	-	-	-
Bidasoa S.A.	6.1	0.4	-	-	-	60.2	0.5	-	-	-
Pesquera Atlantic Seacove Chile Lt	1.3	0.1	-	-	-	10.7	0.1	-	-	-
Sociedad Baquedano Ltda.	0.9	0.1	-	-	-	6.8	0.1	-	-	-
Mario Augusto Rivera Machuca	0.5	0.0	-	-	-	1.7	0.0	-	-	-
Octomar Importaciones Exportacione	0.2	0.0	-	-	-	1.6	0.0	-	-	-
Subtotal (US/Fresh)	1,693.3	98.8	1,235.1	98.5	-27.2	1,2847.0	99.1	10,891.1	98.4	-15.2

Canada										
Empacadora del Pacífico Ltda.	-	-	12.5	65.7	-	-	-	124.8	68.9	-
Comercial Cisandina Chile S.A.	-	-	5.1	27.0	-	-	-	45.3	25.0	-
Importadora y Exportadora Nanaimo	-	-	1.4	7.3	-	-	-	11.1	6.1	-
Empacadora Montemar S.A.	17.1	100.0	-	-	-	83.5	100.0	-	-	-
Subtotal (Canada/Fresh)	17.1	1.0	19.1	1.5	11.8	83.5	0.6	181.2	1.6	116.9
Argentina										
Pesquera Marazul Ltda.	2.5	83.3	-	-	-	18.1	72.1	-	-	-
Elab. y Comerc. de Alimentos Fin	0.5	16.7	-	-	-	7.0	27.9	-	-	-
Subtotal (Argentina/Fresh)	3.0	0.2	-	-	-	25.1	0.2	-	-	-
Sweden										
Soc. Comercial SBS Ltda.	0.3	100.0	-	-	-	3.0	100.0	-	-	-
Subtotal (Sweden/Fresh)	0.3	0.0	-	-	-	3.0	0.0	-	-	-
U.S.S.R.										
Elab. Y Comerc. de Alimentos Fin	0.2	100.0	-	-	-	2.1	100.0	-	-	-
Subtotal (U.S.S.R./Fresh)	0.2	100.0	-	-	-	2.1	0.0			
Subtotal (Fresh)	1,716.9	94.2	1,254.2	89.0	-27.0	12,960.7	94.8	11,072.3	92.8	-14.6
Frozen										
United States										
Pesquera Omega Ltda.	-	-	61.1	61.1	-	-	-	305.4	56.0	-
Omega Seafoods Ltda.	-	-	38.1	38.1	-	-	-	234.6	43.1	-
Empacadora del Pacífico	-	-	0.9	0.9	-	-	-	4.9	0.9	-
Pesquera Marazul Ltda.	68.5	92.2	-	-	-	462.3	92.9	-	-	-
Pesquera Catalina Ltda.	5.7	7.6	-	-	-	33.5	6.7	-	-	-
Kenbourne Chile Ltda.	0.1	0.2	-	-	-	1.4	0.3	-	-	-
Empacadora Montemar S.A.	0.0	0.0	-	-	-	0.2	0.0	-	-	-
Subtotal (US/Frozen)	74.3	70.5	100.1	64.6	34.6	497.4	70.2	544.9	63.4	9.6
Switzerland										
Andes Sur S.A.	7.0	100.0	10.6	100.0	51.0	56.1	100.0	121.0	100.0	115.6
Subtotal (Switzerland/Frozen)	7.0	6.7	10.6	6.8	51.0	56.1	7.9	121.0	14.1	115.6
Netherlands										
Pesquera Omega Ltda.	-	-	11.8	100.0	-	-	-	58.3	100.0	-
Subtotal (Netherlands/Frozen)	-	-	11.8	7.6	-	-	-	58.3	6.8	-
Uruguay										
Pesquera Omega Ltda.	-	-	16.3	100.0	-	-	-	52.9	100.0	-
Subtotal (Uruguay/Frozen)	-	-	16.3	10.5	-	-	-	52.9	6.2	-
Spain										
Productora y Comerc. del Mar Ltda.	-	-	10.3	100.0	-	-	-	30.8	100.0	-
Subtotal (Spain/Frozen)	-	-	10.3	6.6	-	-	-	30.8	3.6	-

Japan										
Bca. Comercial Ltda.	8.4	51.3	2.9	100.0	-65.3	63.1	65.7	21.9	100.0	-65.3
Empacadora Montemar S.A.	2.4	14.6	-	-	-	13.9	14.5	-	-	-
Empacadora del Pacífico Ltda.	2.6	15.8	-	-	-	13.0	13.5	-	-	-
Pesquera Catalina Ltda.	3.0	18.3	-	-	-	6.0	6.3	-	-	-
Subtotal (Japan/Frozen)	16.4	15.6	2.9	1.9	-82.2	96.0	13.5	21.9	2.5	-77.2
Argentina										
Pesquera Marazul Ltda.	7.5	100.0	1.5	73.2	-80.0	58.0	100.0	10.2	56.6	-82.4
Elab. y Comerc. de Alimentos Fin.	-	-	0.5	26.8	-	-	-	7.8	43.4	-
Brazil										
Elab. Y Comerc. de Alimentos Fin.	-	-	0.6	82.6	-	-	-	7.1	79.9	-
Chisal S.A.	-	-	0.1	17.4	-	-	-	1.8	20.1	-
Subtotal (Brazil/Frozen)	-	-	0.7	0.4	-	-	-	8.9	1.0	-
Russia										
Elab. y Comerc. de Alimentos Fin.	-	-	0.2	100.0	-	-	-	2.4	100.0	-
Subtotal (Russia/Frozen)	-	-	0.2	0.2	-	-	-	2.4	0.3	-
U.S.S.R.										
Empacadora Montemar S.A.	0.1	80.2	-	-	-	1.0	74.2	-	-	-
Elab. y Comerc. de Alimentos Fin.	0.0	19.8	-	-	-	0.3	25.8	-	-	-
Subtotal (U.S.S.R./Frozen)	0.1	0.1	-	-	-	1.3	0.2	-	-	-
Subtotal Frozen	105.4	5.8	154.8	11.0	46.9	708.8	5.2	859.2	7.2	21.2
Smoked										
Bolivia										
De Veer Berti Vincent Eckart	-	-	0.0	100.0	-	-	-	0.4	100.0	-
Subtotal (Bolivia/Smoked)	-	-	0.0	100.0	-	-	-	0.4	100.0	-
Subtotal Smoked	-	-	0.0	0.0	-	-	-	0.4	0.0	-
Grand Total (All swordfish exports)	1,822.2	100.0	1,409.0	100.0	-22.7	13,669.4	100.0	11,931.8	100.0	-12.7

- No movement
Source: *Sistema de Información Pesquera. Boletin de Estadísticas*, N° 6, June, 1995 (IFOP: Santiago, Chile), pp. 74-75.

Appendix I.--Chile. Addresses

Government agencies

Administración de Puertos - Coquimbo:
Empressa Desarrollo de Chile
Casilla No. 10-D
Coquimbo
CHILE
Tel: (56-51) 313-606; 311-104
FAX: (56-51) 326-143

Subsecretaría de Pesca (SSP/SUBPESCA)
Ministerio de Economía
Bellavista 168, piso 19
Valparaíso
CHILE
Tel: (56-32) 234-315/16
FAX: (56-32) 212-790

Servicio Nacional de Pesca (SERNAP/SERNAPESCA):
National headquarters:
Yungay Nº 1731, piso 4°
Valparaiso, CHILE
Tel: (56-32) 214-371
FAX: (56-32) 259-564

San Antonio:
Barros Luco 2211
San Anonio
CHILE
Tel: (56-35)-282-843
Fax: (56-35)-282-930

Research groups

Instituto de Fomento Pesquero (IFOP):

Santiago:

Casilla 1287
Santiago
CHILE
Tel: Santiago (56-2) 225-4362, 217-817, 210-256, 633-9753
FAX: Valparaíso: (56-32) 213-178

Valparaiso:

Huito 374
Valparaiso
CHILE
Tel: (56-32)-212-630; 212-811
Fax: (56-32)-212-798; 213-178;

Universidad Católica de Valparaiso:
Valparaiso
Chile
Tel: (56-32)-251-024; 281-867
E-mail: eyanez@aix1.ucv.cl

Universidad Católica de la Santa Concepción:
Caupolican 291
Casilla 297
Concepción
Chile
Tel: (56-41)-480-270
Fax: (56-41)-480-276

Facultad Ciencias del Mar:
Universidad Católica del Norte
Coquimbo
CHILE

Industry groups

Asociación de Pescadores de Valparaíso:
address and telephon number unavailable

Asociación Gremial de Industriales Pesqueros (ASIPES): address and telephone number unavailable

Asociación Nacional de Pescadores Artesanales de Chile (AMPACH):
Casilla 273
Talcahuano
CHILE

Sociedad Nacional de Pesqueria (SONAPESCA):
Ahumada 254, Of. 1107
Santiago
CHILE
Tel: (56-2) 695-1122; 698-0221
FAX: (56-2) 698-2019; 671-5477

Pescadores Artesanales de San Vicente:
Puerto Pesquero de San Vicente
P. Montt Nº 801 - 541323
San Vicente
Talcahuano, VIII Reg.
CHILE

Sindicato de Puertecito de San Antonio:
address and telephone number unavailable

Companies

Agropesca:
RUT: 96537870-7
Av. Argentina 3097
Arica
Tel: (58) 212571; 211-839
FAX: (58) 212-491

Alimentos Multiexport:
RUT: 96513230-9
Americo Vespucio Sur 842
Santiago
CHILE
Tel: 228-6470; 228-3642
FAX: 228-6263
Plant:
Cardonal 2501
Puerto Montt
Tel: (65) 254-984
FAX: (65) 255-500

Andesur Exportaciones e Importaciones:
Av. Manquehue Norte 1901
Santiago
CHILE
Tel: (56-2) 218-1111
FAX: (56-2) 218-6877

BCA Comercial:
Address and telephone number unavilable

Comercializadora y Elabadora de Productos
del Mar y Hortofruitcolas y Prestacion
de Servicios:
R.U.T. 7102336-2
Las Heras 2241, Recinto Frigorífico
Concepción
Chile
Tel: (56-41) 235-753
Fax: (56-41) 235-753

Comercial Mar Andino:
R.U.T. 79835900-2
Av. Presidente Riesco 3198
Santiago
Chile
Tel: (56-2) 233-0618
Telex: (56-2) 341-559

(Vincent) Eckart De Veer Berti:
Rafael Sotomayor 611
Arica
CHILE
Tel: (56-58) 250-143
FAX: (56-58) 232-195

Empacadora Montemar:
RUT: 96548230-K
Av. General Bonilla 9469\Pudahuel
Santiago
CHILE
Tel: 643-1087
FAX: 643-5119
Plant:
Puerto San Antonio
Tel: (35) 211-907
FAX: (35) 211-907

Empacadora del Pacífico:
Ferrari 80
Santiago
CHILE
Tel: (56-2) 558-9988
FAX: (56-2) 558-1716

Importadora y Exportadora Nanaimo:
Camino La Vara 02980
San Bernardo
Santiago
CHILE
Tel: (56-2) 528-3995, 528-0443

Kufax
Address unavailable

Mendoza Hozman:
Address or telephone number not available

Muñoz Concha:
Las Heras 2241
Concepción
Chile
Telfax: (56-31)-310-823

New Bay Products:
address unavailable
Tel: (56-2)-334-1891
Fax: (56-2)-231-3190

Pesca Chile:
Address and telephone number unavilable

Pesquera Catalina:
Av. Barros Luco 2082
San Antonio
Tel: (56-35) 232-300, 282-856
FAX: (56-35) 233-419

Pesquera Continental:
Address or telephone number unavailable

Pesquera Cuyaima:
R.U.T. 84900800-5
Av. Molo Sur s/n
San Antonio
Tel: (56-35) 211-639; 211-654
Fax: (56-35) 211-639

Pesquera del Estrecho:
R.U.T. 96514230-4
Ahumada 370, Of. 631
Santiago
Chile
Tel: (56-2) 696-0877

Pesquera Grimar:
RUT: 96537880-4
Monseñor Sotero Sanz 55
Of. 90
Casilla 16326 Correo 9
Santiago
CHILE
Tel: 231-9855; 362-1777
FAX: 232-1072; 233-2755
Plants:
- Las Heras 2241
Concepción
Tel: (41) 226-482; 314-434
FAX: (41) 226-482
- Sector Nudo Naron s/n
Valparaiso
Tel: (32) 218-204
FAX: (32) 218-204
- Rengifo 430-A
Puerto Montt
Tel: (65) 259-982

Pesquera Isla del Rey:
Los Condestables 390
Niebla, Valdivia
CHILE
Tel: (56-63) 282-176

Pesquera Lacks:
Address unavailable
Tel/FAX: (56-32) 662-955

Pesquera Marazul:
RUT: 79707240-0
Washington 230
Valparaiso
CHILE
Tel: 239-157
FAX: 239-157
Plant:
- Los Aromos 551, Aguas Buenas
San Antonio
Tel: 286-110, 211-757
FAX: (35) 231-624, 212-072
- Iquique 5803
Antofagasta

Pesquera Montemar:
Address unavailable
Tel: (32)-832-702

Pesquera Omega:
RUT: 79707050-5
Chinquihue, Km 12.4
Casilla 13D
Puerto Montt
CHILE
Tel: (65) 257-541/2-3
FAX: (65) 257-455
Other plant
- Guillermo Edwards 40
Coquimbo
Tel: (56-51) 323-344, 323-366
FAX: (56-51) 323-355

Pesquera Omega:
Edwards 80
Coquimbo
CHILE
Tel: (56-51)-323-344
FAX: (56-51)-323-355

Pesquera Catalina:
Av. Barros Luco 2082
Casilla 31
San Antonio
CHILE
Tel: (56-35) 282-856
FAX: (56-35) 233-419

Pesquera Sabropesca:
R.U.T. 86176300-5
Avda. Principal 130
Cantera Baja
Coquimbo
Chile
Tel: (56-51) 322-371; 314-225
Fax: (56-51) 324-4107

Pesquera Santa Lucía (closed):
R.U.T.
96527920-2
Camino Publico s/n
Quintero
CHILE
Tel: (56-32) 931-541; 931-542
Fax: (56-32) 931-543

San Antonio Plant:
Molo Sur s/n
San Antonio
Tel: (56-09)-324-1846

Pesquera Santo Domingo:
R.U.T. 96513210-4
Ruta 78 5605 # 85
San Antonio
Chile
Tel: (56-35) 212-110
FAX: (56-35) 212-448

Soc. Com. Frigorifico Valparaiso:
R.U.T. 78038030-6
Ruta 68 1240, Placilla
Valparaiso
Chile
Tel: (56-32) 291-165; 291-166; 291-167
Fax: (56-32) 291-167

Sociedad Pesquera Mamiña:
R.U.T. 96508940-3
Entre Galpones 2 y 3
Puerto San Antonio
San Antonio
Chile
Tel: (56-35) 282-216; 282-266
Fax: (56-35) 282-266

Sociedad Reyes del Mar:
R.U.T. 79683810-8
Anibal Pinto 222, Of. 161
Talcahuano
Chile
Tel: (56-41) 545-858
Fax: (56-41) 545-858

SERIES J APPENDICES: TRADE

J1: Overall fisheries trade
J2: Overall swordfish trade
J3: United States swordfish exports
J4: European Union swordfish exports
J5: Japanese swordfish exports

Appendix J1a.--Chile. Fishery exports, 1990-96

Year	Exports	
	Value	Change
	US$1,000	Percent
1990	724.6	-
1991	936.6	+29
1992	1,179.8	+26
1993	1,078.2	- 9
1994	1,292.0	+20
1995	1,782.3	+38
1996	1,771.9	- 1

Note: Data differes with FAO statistics (Latin America, appendix E1) for most years. These differences are unexplained
Source: Subsecetaría de Pesca (SSP), *Sector Pesquero: Informe Consolidado*, various years, (SSP: Valparaíso, various years).

Appendix J1b.--Chile. Fishery exports, 1994-96

Commodity	Value			Change		Proportion		
	1994	1995	1996	94/95	95/96	1994	1995	1996
	US$ Million					Percent		
Frozen	516	658	622	+28	- 6	38	37	35
Meal	454	633	612	+39	- 3	33	36	35
Fresh	170	219	258	+29	+18	12	12	15
Canned	104	119	113	+14	- 5	8	7	6
Agar-agar	33	40	45	+21	+13	2	2	3
Oil	44	49	44	+11	-10	3	3	2
Other	45	64	78	+42	+22	3	4	4
Total*	1,366	1,782	1,772	+30	-1	100	100	100

P - Preliminary
* Totals may not agree due to rounding.
Source: Subsecretaría de Pesca, *Sector Pesquero: Informe Consolidado*, various years (SSP: Valparaíso, various years).

Appendix J2a.--Chile. Swordfish exports, 1985-96

Year	Exports	
	Quantity	Value
	Metric tons	U.S.$1,000
1985	201	934
1986	694	3,798
1987	1,619	11,252
1988	2,723	18,831
1989	4,569	28,095
1990	4,672	25,285
1991	5,998	39,652
1992	4,751	35,978
1993	3,757	28,775
1994	3,063	22,762
1995	2,567	21,275
1996	2,245	19,107

Note: Chilean export data (appendix J2e) and U.S. import data (appendix J3a1) show substantial differences which are not fully understood. The authors believe that the U.S. Customs Service may not be identifying all of the swordfish exported by Chile. Most Latin American countries export swordfish primarily as relatively easily identifiable trunks. Chilean companies, however, are processing substantial quantities of swordfish and some of the resuling fillets, loins, and other products may be included in various basket categotries for unspecified marine fish. Steve Koplin, NMFS, personal communications, December 27, 1996. As a result, the authors are using Chilean export data rather than U.S. import data.
Source: Pedro Brunetti Barroso, Subsecretaría de Pesca, personal communications, October 3, 1995, December 19, 1996, and July 4, 1997.

Appendix J2b.--Chile. Swordfish exports, 1989-96

Year	Quantity			Value			Proportion fresh*
	Fresh	Frozen	Total	Fresh	Frozen	Total	
	Metric tons			U.S.$1,000			Percent
1985	NA	NA	201	NA	NA	934	NA
1986	NA	NA	694	NA	NA	3,798	NA
1987	NA	NA	1,619	NA	NA	11,252	NA
1988	NA	NA	2,723	NA	NA	18,831	NA
1989	4,334	235	4,569	26,797	1,298	28,095	95
1990	4,323	349	4,672	23,638	1,647	25,285	93
1991	4,916	1,082	5,998	33,389	6,263	39,652	84
1992	3,650	1,101	4,751	27,397	8,581	35,978	76
1993	3,186	571	3,757	25,087	3,688	28,775	87
1994	2,791	272	3,063	20,909	1,854	22,762	92
1995	2,298	269	2,567	19,790	1,485	21,275	93
1996	1,984	262	2,245	17,317	1,567	19,107	91

* Proportion of swordfish shipped fresh in value terms.
Source: Pedro Brunetti Barroso, Subsecretaría de Pesca, personal communications, October 3, 1995, December 10, 1996, and July 4, 1997.

Appendix J2c1.--World. Swordfish imports from Chile, 1990-96

Destination	Year						
	1990	1991	1992	1993	1994	1995	1996
	Metric tons						
United States	4,355	4,041	3,320	2,227	1,180	1,089	856
Japan*	58E	91E	70E	26E	21E	21E	19E
European Union	307**	593	312	17	Negl	8	5C
Others****	39	74	82	87	87	188	210C
Total	4,759	4,799	3,784	2,357	1,288	1,306	1,090EC

C - EU and other foreign data not availble. Chilean data from appendix J2c2 inserted.
E - NMFS estimate based on available data for all billfish imports.
* Japan has a general import category for all billfish, but NMFS believes that virtually all of the product imported from Chile is swordfish
** The EU did not have a separate category for swordfish until 1991. Chilean export data (appendices J2c1 and J4b), however, reveals shipments of about 307 tons.
*** Small quantity of frozen fillets
Source: U.S. Bureau of the Census, EU. Eurostat data, and Japan Tariff Association, *Japan Exports & Imports*, various years.

Appendix J2c2.--World. Swordfish imports from Chile, 1990-96

Destination	Year						
	1990	1991	1992	1993	1994	1995	1996
	Metric tons						
United States	4,257	5,039	4,383	3,613	2,976	2,379	1,989
Japan*	62	98	69	48	29	18	41
European Union	307	804	232	Negl	Negl	65	5
Others****	39	74	82	87	87	188	210
Total	4,665	6,015	4,766	3,748	3,092	2,650	2,245

Source: Pedro Brunetti Barroso, Subsecretaría de Pesca, personal communications, October 3, 1995; December 10, 1996; and July 4, 1997.

Appendix J2d.--Chile. Swordfish trade, discrepancy between United States (import) and Chilean (export) statistics, 1990-96

Year	Swordfish		Difference	
	Imports	Exports	Absolute	Proportion
	Metric tons		Metric tons	Percent
1990	4,355	4,257	+ 98	+ 2
1991	4,041	5,039	- 998	-25
1992	3,320	4,383	-1,063	-32
1993	2,227	3,613	-1,386	-62
1994	1,180	2,976	-1,796	-152
1995	1,089	2,379	-1,290	-118
1996	856	1,989	-1,133	-132

The substantial differences noted since 1993 are not fully understood. One possibility is that U.S. Customs is including a substantial portion of processed swordfish products in basket categories for miscellaneous marine fish.
Source: Appendices J2e Chilean exports) and appendix J3a1 (U.S. imports).

Appendix J2e.--Chile. Swordfish exports by destination, 1985-96

Year	Quantity			Value			Proprtion
	U.S.	Other	Total	U.S.	Other	Total	U.S.
	Metric tons			US$1,000			Percent*
1985	-	201	201	-	934	934	-
1986	-	694	694	-	3,798	3,798	-
1987	1,503	116	1,619	11,134	118	11,252	99#
1988	2,590	133	2,723	18,018	813	18,831	96
1989	4,356	213	4,569	26,978	1,117	28,095	96
1990	4,257	415	4,672	23,217	2,068	25,285	92
1991	5,039#	959#	5,998#	34,376#	5,276#	39,652#	87
1992	4,383	368	4,751	33,494	2,484	35,978	93
1993	3,613	144	3,757	27,794	981	28,775	97
1994	2,976	87	3,063	22,205	557	22,762	98
1995	2,379	188	2,567	20,155	1,120	21,275	95
1996	1,989	256	2,245	17,616	1,491	19,107	92

* By value
\# Record
Source: Pedro Brunetti Barroso, Subsecretaría de Pesca, personal communications, October 3, 1995; December 10, 1996; and July 4, 1997.

Appendix J2f1.--Chile. Swordfish exports by country of destination, 1990-96

Commodity/ country	Quantity						
	1990	1991	1992	1993	1994	1995	1996
	Metric tons						
Fresh							
United States	4,025	4,485	3,650	3,102	2,766	2,269	1,950
Uruguay	-	-	-	-	-	-	16
Canada	34	60	33	49	21	28	10
Spain	239	352	174	-	-	-	5
Switzerland	-	-	-	-	-	1	1
Suriname	-	-	-	-	-	-	1
Paraguay	-	-	-	-	-	-	Negl
Brazil	-	-	-	-	-	-	Negl
France	17	24	18	-	-	Negl	-
Argentina	-	-	3	-	3	-	-
Japan	-	-	1	-	1	-	-
Sweden	2	2	2	Negl	Negl	-	-
Russia	-	Negl	Negl	-	Negl	-	-
Germany	-	-	Negl	-	-	-	-
Italy	-	3	-	-	-	-	-
Portugal	-	Negl	-	-	-	-	-
Others	-	-	-	33	-	-	-
Total	4,323	4,917	3,650	3,186	2,791	2,298	1,984
Frozen							
Uruguay	-	-	-	-	-	50	153
Japan	62	98	68	48	28	18	41
United States	233	555	962	512	210	110	39
Switzerland	-	-	10	-	14	19	21
Korea	-	-	-	-	-	3	7
Brazil	-	-	-	-	-	1	1
Russia	-	-	-	-	Negl	Negl	Negl
Argentina	-	7	12	-	12	4	Negl
Paraguay	-	-	-	-	-	-	Negl
Spain	22	302	39	-	-	32	-
Germany	-	24	-	Negl	Negl	21	-
Netherlands	-	81	-	-	-	12	-
Canada	-	-	12	-	6	-	-
Argentina	-	Negl	8	-	-	-	-
Sweden	3	1	2	-	-	-	-
France	20	-	1	-	-	-	-
Italy	3	18	-	-	-	-	-
Niger	-	4	-	-	-	-	-
Bolivia	-	Negl	-	-	-	-	-
Portugal	6	-	-	-	-	-	-
Others	-	-	-	5	Negl	-	-
Total*	349	1,082	1,102	565	272	269	262
Canned							
Brazil	Negl	-	-	-	-	-	
Cured							
Argentina	-	Negl	Negl	-	-	-	
Total*	4,672	5,999	4,752	3,753	3,063	2,567	2,245

* Totals may disagree due to rounding.
Source: Subsecretaria de Pesca, unpublished statistics, May 16, 1995; December 10, 1996; and July 7, 1997.

Appendix J2f2.--Chile. Swordfish exports by country of destination, 1990-96

Commodity/ country	Value						
	1990	1991	1992	1993	1994	1995	1996
				US$1,000			
Fresh							
United States	21,967	30,477	25,663	24,386	20,755	19,528	17,317
Canada	193	417	260	412	101	257	90
Uruguay	-	-	-	-	-	-	85
Spain	1,317	2,360	1,304	-	-	-	27
Switzeland	-	-	-	-	-	5	10
Suriname	-	-	-	-	-	-	9
Paraguay	-	-	-	-	-	-	1
Brazil	-	-	-	-	-	-	Negl
France	146	116	147	-	-	Negl	-
Argentina	-	-	-	-	25	-	-
Sweden	16	-	23	17	3	-	-
Japan	-	-	3	-	3	-	-
Russia	-	1	2	-	2	-	-
Italy	-	25	-	-	-	-	-
Portugal	-	1	-	-	-	-	-
Germany	-	-	Negl	-	-	-	-
Others	-	-	-	271	-	-	-
Total	23,638	33,395	27,398	25,087	20,909	19,790	17,540
Frozen							
Uruguay	-	-	-	-	-	203	689
United States	1,254	3,904	7,842	3,412	1,431	627	299
Japan	118	237	243	198	135	122	278
Switzerland	-	-	88	-	141	206	227
Brazil	-	-	-	-	-	18	35
Korea	-	-	-	-	-	15	31
Argentina	-	1	68	48	95	33	6
Paraguay	-	-	-	-	-	Negl	2
Spain	78	1,438	243	-	-	114	-
Germany	-	-	-	-	6	85	-
Netherlands	-	407	-	-	-	58	-
Russia	-	-	-	-	-	2	-
Canada	-	-	78	-	44	-	-
Sweden	23	5	15	-	-	-	-
France	125	119	7	-	-	-	-
Italy	24	146	-	-	-	-	-
Niger	-	9	-	-	-	-	-
Bolivia	-	Negl	-	-	-	-	-
Portugal	26	-	-	-	-	-	-
Others	-	-	-	31	1	2	-
Total	1,648	6,266	8,584	3,689	1,854	1,485	1,567
Canned							
Brazil	3	-	-	-	-	-	-
Cured							
Bolivia	-	-	-	-	-	Negl	-
Argentina	-	3	4	-	-	-	-
Total	25,289	39,664	35,987	28,776	22,762	21,275	19,107

Source: Subsecretaria de Pesca, unpublished statistics, May 16 and October 3, 1995; December 10, 1996; and July 4, 1997.

Appendix J2f3.--Chile. Swordfish prices by country of destination, 1990-96

Commodity/ country	Nomimal prices*						
	1990	1991	1992	1993	1994	1995	1996
				US$/kg			
Fresh							
Paraguay	-	-	-	NA	-	-	12.00**
Switzerland	-	-	-	NA	-	9.00	9.36**
Canada	5.76	6.97	7.99	8.41	4.81	9.06	8.89
United States	5.46	6.80	7.50	7.86	7.51	8.61	8.88
Suriname	-	-	-	NA	-	-	7.75
Spain	5.51	6.71	7.49	NA	-	-	5.83
Uruguay	-	-	-	NA	-	-	5.17
Brazil	-	-	-	NA	-	-	3.00**
France	6.02	6.82	8.00	NA	-	9.00	-
Russia	-	-	-	NA	10.29	-	-
Argentina	-	-	-	NA	8.35	-	-
Sweden	8.70	-	9.11	NA	8.99	-	-
Japan	-	-	-	NA	3.18	-	-
Germany	-	-	2.50	NA	-	-	-
Italy	-	7.56	-	NA	-	-	-
Portugal	-	6.46	-	NA	-	-	-
Others	-	-	-	8.21	-	-	-
Average	5.47	6.79	7.51	7.87	7.49	8.61	8.84
Frozen							
Brazil	-	-	-	NA	-	13.87	25.07**
Argentina	-	9.20	8.40	NA	7.80	7.82	13.75**
Paraguay	-	-	-	NA	-	10.23	11.50**
Switzerland	-	-	8.70	NA	9.80	10.88	11.00
United States	5.38	7.03	8.15	6.66	6.80	5.71	7.72
Japan	1.88	2.42	3.58	4.13	4.88	6.87	6.79
Korea	-	-	-	NA	-	6.00	4.72*
Uruguay	-	-	-	NA	-	4.05	4.51
Russia	-	-	-	NA	-	10.11	-
Netherlands	-	5.05	-	NA	-	4.96	-
Germany	-	5.00	-	NA	15.22	4.09	-
Spain	3.58	4.76	6.27	NA	-	3.60	-
Soviet Union	-	-	-	NA	10.63	-	-
Canada	-	-	6.58	NA	6.99	-	-
Sweden	6.70	9.00	8.18	NA	-	-	-
France	6.25	-	7.19	NA	-	-	-
Italy	8.00	8.01	-	NA	-	-	-
Bolivia	-	7.81	-	NA	-	-	-
Niger	-	2.33	-	NA	-	-	-
Portugal	4.75	-	-	NA	-	-	-
Others	-	-	-	6.20	-	-	-
Average	4.72	5.79	7.79	6.49	6.83	5.51	5.99
Canned							
Brazil	10.63	-	-	NA	-	-	-
Smoked							
Brazil	-	-	-	NA	-	18.00	-
Argentina	-	14.03	14.00	NA	-	-	
Average	5.41	6.61	7.57	7.66	7.43	8.29	8.51

NA - Not available
* Nomimal export prices (FOB)
** Very small quantities involved.
Note: The difference in price is at least in part due to the varying commidity (product form) mix imported by each country.
Source: Subsecretaria de Pesca, unpublished statistics, May 16 and October 3, 1995; December 10, 1996; and July 4, 1997.

Appendix J2g.--Chile. Swordfish exports, by product form, 1993-96

Product form	Quantity				Value			
	1993	1994	1995	1996	1993	1994	1995	1996
	Metric tons				US$Million			
Fresh	3,186	2,791	2,298	1,984	25,087	20,909	19,790	17,540
Frozen	565	272	269	262	3,689	1,854	1,485	1,567
Cured	-	-	Negl	-	-	-	-	-
Total	3,753	3,063	2,567	2,245	28,766	22,763	21,275	19,107

Source: IFOP, *Boletin Informativo SIM*, various issues and Subsecretaria de Pesca, unpublished statistics, July 4, 1997.

Appendix J2h1.--Chile. Swordfish exports, by product form, 1993-96

Product form		Quantity				Value			
English	Spanish	1993	1994	1995	1996	1993	1994	1995	1996
		Metric tons				US$ Million			
Fresh									
Loin	Lomo	1,201	1,245	501	450	9.4	9.1	4.6	4.4
H&G*	H&G*	631	801	730	658	4.8	5.1	5.2	4.8
Portions	Trozado***	1,035	480	476	313	8.4	4.3	4.4	2.9
Fillet**	Filete**	220	237	512	379	1.7	2.2	4.9	3.7
H&G****	H&G****	102	25	80	135	0.7	0.2	0.7	1.2
Loin prtions	Lomo trozado	-	-	-	45	-	-	-	0.4
Whole	Entero	-	-	-	5	-	-	-	Negl
Subtotal#		3,186	2,791	2,298	1,984	25.1	20.9	19.8	17.5
Frozen									
Fillet**	Filete**	367	140	166	61	2.4	1.0	1.0	0.6
Loin	Lomo	46	97	18	4	0.3	0.6	0.2	Negl
Steak	Steak/rebanades+	14	16	-	2	0.1	0.1	-	Negl
Belly flap	Estomogo	43	17	6	11	0.2	0.1	Negl	0.1
Portions	Trozado***	NA	2	4	33	NA	Negl	Negl	0.2
H&G*	H&G*	NA	1	76	151	NA	Negl	0.3	0.7
Loin portions	Lomo trozado	NA	NA	-	Negl	-	-	-	Negl
Other	Otra	NA	NA	-	Negl	-	-	-	Negl
Subtotal#		565	272	269	262	3.7	1.9	1.5	1.6
Cured									
Lomo		NA	-	Negl	-	Negl	-	Negl	-
Total#		3,753	3,063	2,567	2,245	28.8	22.8	21.3	19.1

* Headed and gutted with the tail
** Without bones
*** Including ??? ("panes") and portions ("porciones").
**** Headed and gutted without the tail
# Totals may not agree due to rounding.
+ also "rodajas"
Source: IFOP, SIM No. 30 and 34, February 1995 and March 1996 and M. Isabela Ortego O, Investigador, Departamento Economia Pesquera, Instituto de Fomento Pesquero, unpublished data, August 23, 1997.

Appendix J2h2.--Chile. Swordfish exports, by product form, 1993-96

Product form		Quantity				Value			
English	Spanish	1993	1994	1995	1996	1993	1994	1995	1996
					Percent				
Fresh									
Loin	Lomo	38	45	22	23	38	44	23	25
H&G*	H&G*	20	29	32	33	19	25	26	27
Portions	Trozado***	33	17	21	16	34	21	23	17
Fillet**	Filete**	7	9	22	19	7	10	25	21
H&G****	H&G****	3	1	4	7	3	1	3	7
Loin portions	Lomo trozado	-	-	-	2	-	-	-	2
Whole	Entero	-	-	-	Negl	-	-	-	Negl
Subtotal#		100	100	100	100	100	100	100	100
Frozen									
Fillet**	Filete**	65	51	62	23	66	55	65	38
Loin	Lomo	8	36	7	2	9	35	12	Negl
Steak	Steak	2	6	-	1	3	6	-	Negl
Belly flap	Estomogo	8	6	2	4	6	3	2	6
Portions	Trozado***	NA	1	2	13	NA	1	2	13
H&G*	H&G*	NA	Negl	28	58	NA	Negl	19	44
Loin portions	Lomo trozado	NA	NA	-	Negl	NA	NA	-	Negl
Other	Otra	NA	NA	-	Negl	NA	NA	-	Negl
Subtotal#		100	100	100	100	100	100	100	100
Cured									
Lomo		NA	NA	100	-	NA	NA	100	-

Totals may not agree due to rounding.
* Headed and gutted trunks with the tail
** Without bones
*** Including ??? ("panes") and portions ("porciones").
**** Headed and gutted trunks without the tail
Source: IFOP, SIM No. 30 and 34, February 1995 and March 1996.

Appendix J2i.--Chile. Swordfish exports and estimated domestic consumption, 1985-96

Year	Catch	Exports		Apparent domestic consumption**
		Product	LW equivalent*	
		Metric tons		
1985	342	201	251	91
1986	764	694	868	-104
1987	2,059	1,619	2,024	35
1988	4,455	2,723	3,404	1,051
1989	5,824	4,569	5,711	113
1990	4,955	4,672	5,840	-885
1991	7,255	5,998	7,498	-243
1992	6,379	4,751	5,939	440
1993	4,712	3,757	4,696	16
1994	3,801	3,063	3,829	-28
1995	2,594	2,567	3,209	-615
1996	3,145	2,245	2,806	-339

Note: The comparison of catch and live-weight equivalents of export shipments in several years show exports exceeding catches. The authors can not explain these statistical irregularities. The basic conclusion is, however, that with a few exceptions, very small quantities of swordfish are being marketed domestically.
* Live-weight equivalent of Chilean exports. Export commodities are computed on the basis of 80 percent of live weight which is the approximate ratio for trunks. As Chilean companies process substantial quantities of swordfish, the actual ratio would be somewhat lower.
** Catch minus live-weight equivalent of exports
Source: Appendices E2a1 (catch) and J2b (Chilean exports).

Appendix J2j.--Chile. Monthly swordfish exports, 1995-97

Month	Year		
	1995	1996	1997
		US$1,000	
January	278	198	599
February	116	309	132
March	783	303	290
April	2,442	1,121	
May	3,618	3,980	
June	4,696	3,276	
July	2,567	3,191	
August	2,305	2,643	
September	2,352	1,180	
October	955	1,516	
November	542	972	
December	623	418	
Total*	21,275	19,107	

Source: IFOP, SIM, various issues.

Appendix J3a1.--United States. Swordfish imports from Chile, 1980-96

Year	Quantity			Value			Nominal prices	
	Fresh	Frozen	Total	Fresh	Frozen	Total	Fresh	Frozen
	Metric tons			U.S.$1,000			US$/kg	
1975	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-
1977	-	-	-	-	-	-	-	-
1978	-	-	-	-	-	-	-	-
1979	-	-	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-
1983	6.5	-	6.5	24	-	24	3.69	-
1984	11.3	2.8	14.1	61	11	72	5.39	3.93
1985	156.3	-	156.3	804	-	804	5.14	-
1986	440.4	10.2	450.6	2,604	54	2,658	5.91	5.29
1987	941.9	39.2	981.1	6,452	267	6,719	6.85	6.81
1988	1,732.3	127.4	1,859.7	11,789	870	12,659	6.81	6.82
1989	3,918.6	204.5	4,123.1	24,406	1,167	25,573	6.23	5.71
1990	4,146.6#	207.9	4,354.5#	22,910	1,156	24,066	5.53	5.56
1991	3,844.9	196.2	4,041.1	24,765#	1,377	26,142#	6.44	7.02
1992	2,893.9	426.4	3,320.3	18,254	2,813#	21,067	6.31	6.59
1993	1,772.6	454.7#	2,227.3	13,438	2,504	15,942	7.58	5.51
1994	1,095.5	84.7	1,180.2	8,115	579	8,694	7.41	6.84
1995	1,087.9	1.5	1,089.3	8,352	13	8,366	7.68	8.67#
1996	855.6	-	855.6	7,315	-	7,315	8.55#	-
1997*	535.0	304.6	839.6	4,048	461	4,509	7.57	1.51

Note: Nomimal prices computed from Chilean exports are shown in appendix G4a. There are substantial differences, but show similar trends.
* Through June.
# Record
Source: U.S. Bureau of the Census

Appendix J3a2.--United States. Swordfish imports from Chile, 1980-96

Year	Value			Proportion fresh
	Fresh	Frozen	Total	
	U.S.$Million			Percent
1980	-	-	-	-
1981	-	-	-	-
1982	-	-	-	-
1983	24	-	24	100
1984	61	11	72	85
1985	804	-	804	100
1986	2,604	54	2,658	98
1987	6,452	267	6,719	96
1988	11,789	870	12,659	93
1989	24,406	1,167	25,573	95
1990	22,910	1,156	24,066	95
1991	24,765	1,377	26,142	95
1992	18,254	2,813	21,067	87
1993	13,438	2,504	15,942	84
1994	8,115	579	8,694	93
1995	8,352	13	8,366	100
1996	7,315	-	7,315	100

Source: U.S. Bureau of the Census.

Appendix J3b.--United States. Swordfish imports from Chile, by Customs District, 1990-96

Commodity/ district	Year 1990	1991	1992	1993	1994	1995	1996
				Metric tons			
Fresh							
Boston	12.3	1.8	11.5	32.6	46.1	10.7	2.8
Los Angeles	387.9	257.9	170.7	113.5	170.9	167.2	84.4
Miami	2,742.6	2,582.7	2,339.4	1,257.1	825.3	866.2	712.2
New York	1,003.9	981.0	293.8	313.9	53.2	40.7	56.3
Philadelphia	-	20.0	78.5	54.1	-	-	-
San Franciso	-	1.5	-	1.3	-	3.0	-
Subtotal	4,146.7	3,844.9	2,893.9	1.772.5	1,095.5	1,087.8	855.7
Frozen							
Houston/Galveston	-	-	7.4	-	-	-	-
Los Angeles	28.6	1.9	0.4	-	18.1	1.5	-
Miami	77.1	149.1	385.1	424.9	65.2	-	-
New York	102.2	45.3	33.6	4.2	1.4	-	-
Philadelphia	-	-	-	25.6	-	-	-
Subtotal	207.9	196.3	426.5	454.7	84.7	1.5	-
Total*	4,354.5	4,041.1	3,320.3	2,227.3	1,180.2	1,089.3	855.7

* Totals may not agree due to rounding.
Source: U.S. Bureau of the Census

Appendix J3c1.--United States. Imports of fresh swordfish, 1994-96

Country	1994 Value US$1,000	1994 Proportion Percent	Country	1995 Value US $1,000	1995 Proportion Percent	Country	1996 Value US $1,000	1996 Proportion Percent
Canada	11,544	45	Canada	12,074	41	Chile	7,315	24
Chile*	8,114	32	Chile	8,352	28	Canada	5,625	18
Trinidad	1,397	5	Trinidad	2,319	8	Costa Rica	5,112	17
Mexico	1,353	5	Mexcio	1,545	5	Uruguay	2,721	9
Brazil	805	3	Uruguay	1,051	3	Trinidad	1,894	6
Other	2,352	9	Other	3,519	15	Other	7,846	26
Total**	25,565	100		28,860	100		30,513	100

* Chilean import statistics show greater amounts (appendix J2b) so the actual importance of Chilean shipments may be significantly greater than shown here.
** Totals may not agree due to rounding.
Source: U.S. Bureau of the Census

Appendix J3c2.--United States. Importance of fresh swordfish imports from Chile, by value, 1980-96

Year	Source		World total	Proportion**
	Chile*	Other		
	U.S.$ 1,000			Percent
1980	-	321	321	-
1981	-	614	614	-
1982	-	23	23	-
1983	16	1,323	1,339	1
1984	61	2,822	2,883	2
1985	804	14,082	14,886	5
1986	2,604	26,235	28,839	10
1987	6,453	14,010	20,462	32
1988	11,789	8,028	19,817	59
1989	24,406#	9,396	33,802	72#
1990	22,910	12,466	35,376	65
1991	24,765	14,650	39,415#	63
1992	18,254	18,120	36,374	50
1993	13,438	19,814	33,252	40
1994	8,115	17,450	25,565	32
1995	8,352	20,509	28,861	29
1996	7,315	23,198#	30,513	24

* Proportion from Chile.
** Chilean export statistics indicate larger exports (appendix J2b), so the actual importance of Chilean may be greater than shown here.
# Record
Source: U.S. Bureau of the Census.

Appendix J3d.--United States. Apparent prices** of swordfish imports from Chile, 1980-95

Year	Prices		Difference
	Fresh	Frozen	
	US$/kgMetric tons**		
1982	-	-	NA
1983	3.69*	-	NA
1984	5.40	3.93*	-1.47
1985	5.14	-	NA
1986	5.91	5.29	-0.62
1987	6.85	6.81	-0.04
1988	6.81	6.83	+0.02
1989	6.23	5.71	-0.52
1990	5.53	5.56	+0.03
1991	6.44	7.02	+0.58
1992	6.31	6.60	+0.29
1993	7.58	5.51	-2.07#
1994	7.41	6.84	-0.57
1995	7.68	8.67*#	+0.99
1996	8.55#	-	NA

NA - Not aplicable
* Small quantities involved (less than 10 tons).
** Apparent prices calculated by dividing the value of imports by the quantity (appendix J3a1).
# Record
Source: U.S. Bureau of the Census

Appendix J3e1.--United States. Imports of fresh swordfish, 1994-96

Country	1994 Value	1994 Proportion	Country	1995 Value	1995 Proportion	Country	1996 Value	1996 Proportion
	US$1,000	Percent		US $1,000	Percent		US $1,000	Percent
Canada	11,544	45	Canada	12,074	42	Chile	7,315	24
Chile	8,114	32	Chile	8,352	30	Canada	5,625	18
Trinidad	1,397	5	Trinidad	2,319	8	Costa Rica	5,112	17
Mexico	1,353	5	Mexcio	1,545	5	Uruguay	2,721	9
Brazil	805	3	Uruguay	1,051	4	Trinidad	1,894	6
Venezuela	497	2	Fiji	778	3	Brazil	1,566	5
Other	1,855	7	Other	2,738	9	Other	6,280	21
Total*	25,565	100		28,860	100		30,513	100

* Totals may not agree due to rounding.
Source: U.S. Bureau of the Census

Appendix J3e2.--United States. Apparent prices of fresh swordfish imports, 1994-96

Country	1994 Quantity	1994 Value	1994 Price	Country	1995 Quantity	1995 Value	1995 Price	Country	1996 Quantity	1996 Value	1996 Price
	Metric tons	US$1,000	US$/kg		Metric tons	US$1,000	US$/kg		Metric tons	US$1,000	US$/kg
Major suppliers											
Canada	1,231.9	11,544	9.37	Canada	1,258.4	12,074	9.59	Canada	532.6	5,625	10.56
Chile	1,095.5	8,114	7.41	Chile	1,087.9	8,352	7.68	Chile	855.6	7,315	8.55
Trinidad	240.0	1,397	5.82	Trinidad	417.4	2,319	5.55	Costa Rica	709.1	5,112	7.21
Mexico	261.4	1,353	5.18	Mexico	335.8	1,545	4.61	Trinidad	324.6	1,894	5.83
Uruguay	95.8	387	4.04	Uruguay	297.9	1,052	3.54	Uruguay	479.5	2,721	5.67
Brazil	265.8	805	3.03	Brazil	227.3	752	3.31	Mexico	343.9	1,435	4.17
								Brazil	550.2	1,566	2.84
Lesser Latin American suppliers											
Bermuda#	12.4	132	10.68	Antigua	18.2	160	8.78	Grenada	Negl	2	16.48
St. Vincent	0.4	3	8.74	St. Vincent	0.5	4	7.23	Peru	Negl	5	11.09
Antigua	35.8	302	8.43	Costa Rica	27.3	177	6.47	Barbados	41.4	245	5.91
Peru	0.4	3	6.94	Barbados	63.3	318	5.02	Ecuador	213.1	1,069	5.01
Costa Rica	11.6	75	6.48	Ecuador	80.2	348	4.33	Nicaragua	1.3	9	7.25
Barbados	8.9	44	5.08	Venezuela	89.8	314	3.50	Venezuela	190.4	968	5.09
Venezuela	99.9	497	4.98	Paraguay	3.3	11	3.38	St. Vincent	5.5	26	4.80
Grenada	2.8	14	4.94					Neth. Ant.	12.1	38	3.10
Ecuador	79.6	269	3.38								
Nicaragua	6.1	17	2.74								
All other countries	116.5	1,356	5.26	All other	296.6	1,434	4.83		476.2	28,030	5.21
Totals*											
Excluding Canada##	2,320.5	13,889	5.99		2,945.5	16,786	5.70		4,202.9	24,884	5.92
All countries	3,564.8	25,565	7.17		4,203.9	28,860	6.86		4,735.5	30,513	6.44

* Totals may not agree due to rounding.
\# Caught mostly by Canadian fishermen.
\## The totals excluding the preium Canadian and Bermudan (caught mostly by Canadian fishermen) product may be a better bench mark for comparing Latin American shipments.
Source: U.S. Bureau of the Census

Appendix J3f.--United States. Apparent prices of frozen swordfish imports, 1994-95

Country	1994			Country	1995			Country	1996		
	Value	Quantity	Price		Value	Quantity	Price		Value	Quantity	Price
	US$1,000	Metric tons	US$/kg		US$1,000	Metric tons	US$/kg		US$1,000	Metric tons	US$/kg
Japan	1,807	182.7	9.89	Japan	1,363	140.0	9.74	Japan	867	75.9	11.43
Canada	27	2.9	9.03	Chile	13	1.5	8.67	Indonesia	37	4.7	7.83
Thailand	70	9.9	7.00	Singapore	330	52.4	6.30	Spain	91	13.3	6.86
Chile	579	84.7	6.84	Indonesia	38	6.7	5.63	Singapore	1,161	223.7	5.19
Singapore**	487	92.2	5.28	South Africa	887	159.0	5.58	Taiwan	185	44.9	4.11
Taiwan	1,064	239.0	4.45	Thailand	65	11.7	5.55	Brazil	13	52.9	4.00
Uruguay	376	96.5	3.90	Brazil	3	0.5	5.51	Ecuador	1	0.7	2.71
South Africa	75	19.4	3.86	Taiwan	245	57.2	4.28	Mexico	39	27.6	1.43
Micronesia	3	0.7	3.62	Portugal	3	0.8	4.00				
Mexico	42	12.0	3.55	China	99	45.9	2.16				
China	11	3.2	3.31	Korea (ROK)	5	1.7	2.81				
Brazil	134	70.9	1.89								
Ecuador	1	0.1	NS								
Total*	4,676	814.3	5.74		3,049	477.2	6.39		404	2,435.7	6.03

NS - Not statistically significant
* Totals may not agree due to rounding.
** Shipments from Singapore are almost certainly transhipments from other countries, probably Taiwan and Japan.
Source: U.S. Bureau of the Census

Appendix J3g.--United States. Fresh and frozen swordfish imports by month, 1990-97

Month	Year							
	1990	1991	1992	1993	1994	1995	1996	1997
				Metric tons*				
January	29.1	79.6	84.5	14.6	5.1	7.0	1.4	305.4**
February	157.4	58.0	42.2	9.3	8.3	12.0	20.9	4.9
March	396.5	428.4	165.3	146.3	79.2	20.6	21.1	9.0
April	671.6	579.0	458.6	334.9	187.7	118.5	95.7	89.2
May	1,149.9	764.7	837.7	641.0	262.9	174.0	198.8	205.1
June	722.6	669.2	765.3	472.6	246.4	263.3	169.1	225.9
July	517.8	382.8	431.9	215.5	143.1	139.0	103.2	
August	299.6	506.7	247.7	68.0	110.3	125.4	89.3	
September	177.0	274.7	171.9	180.0	89.1	120.6	32.8	
October	85.5	149.7	39.8	41.0	12.2	36.5	55.7	
November	66.1	109.6	24.1	74.2	7.1	37.9	35.8	
December	81.2	38.7	51.5	29.8	28.7	34.6	31.8	
Total*	4,354.5	4,041.1	3,320.4	2,227.3	1,180.2	1,089.3	885.6	

* Product weight
** Unusually large shipment of frozen product.
Source: Bureau of the Census

Appendix J4a.--European Union. Swordfish imports from Chile, 1991-95

Country	Commodity	Years				
		1991*	1992	1993	1994	1995
		Metric tons				
Denmark	Frozen meat	-	-	-	Negl	-
France	Frozen trunks	1	1	-	-	-
Germany	Frozen trunks	24	-	-	-	-
	Frozen meat	-	-	-	Negl	-
	Frozen fillets	-	-	-	Negl	-
Italy	Fresh	4	-	-	-	-
Netherlands	Frozen trunks	41	-	-	-	-
Spain	Fresh	282	173	17	-	-
	Frozen trunks	241	128	-	-	8
	Frozen fillets	-	10	-	-	-
Total		593	312	17	Negl	8

* 1991 is the first year for which EU swordfish import data is available.
Source: EU. Eurostat data.

Appendix J4b.--Chile. Swordfish exports to European Union countries, 1990-95

Commodity/ country	Quantity						
	1990	1991	1992	1993	1994	1995	1996
	Metric tons						
Fresh							
Spain	239	352	174	-	-	-	5
France	17	24	18	-	-	Negl	-
Germany	-	-	Negl	-	-	-	-
Italy	-	3	-	-	-	-	-
Others	-	Negl	-	-	-	-	-
Total	256	379	192	-	-	-	5
Frozen							
Spain	22	302	39	-	-	32	-
Germany	-	24	-	Negl	Negl	21	-
Netherlands	-	81	-	-	-	12	-
France	20	-	1	-	-	-	-
Italy	3	18	-	-	-	-	-
Portugal	6	-	-	-	-	-	-
Total	51	425	40	Negl	Negl	65	-
Total*	307	804	232	Negl	Negl	65	5

Source: Subsecretaria de Pesca, unpublished statistics, May 16, 1995 and December 10, 1996 and July 7, 1997.

Appendix J4c.--European Union. Comparison of Chilean and EU swordfish trade data, 1986-95

Year	Chilean exports	EU imports	Difference
	Metric tons		
1990	307	NA	NA
1991	804	593	211
1992	232	312	-80
1993	Negl	17	-17
1994	Negl	Negl	-
1995	65	8	57

* General billfish import categories, but the authors believe this is mostly swordfish.
Source: Japan Tariff Association, *Japan Exports & Imports*, various years and Subsecretaria de Pesca, unpublished statistics, May 16 and October 3, 1995 and December 10, 1996.

Appendix J5a.--Japan. Billfish (including swordfish) imports from Chile, 1986-95

Year	Billfish		Total
	Swordfish*	Other	
	Metric tons		
1986	-	-	-
1987	-	-	-
1988	8	-	8
1989	42	-	42
1990	58	-	58
1991	91	-	91
1992	70	-	70
1993	26	-	26
1994	21	-	21
1995	21	-	21
1996	19	-	19

* NMFS estimate, Japan does not have a separate import category for swordfish.
Source: Japan Tariff Association, *Japan Exports & Imports*, various years.

Appendix J5a2.--Japan. Billfish (including swordfish) imports from Chile, 1986-96

Year	Product form			Total*
	Fresh	Frozen		
		Fillets	Other	
	Metric tons			
1986	-	-	-	-
1987	-	-	-	-
1988	-	8**	-	8
1989	-	32**	10	42
1990	-	40**	18	58
1991	-	85**	6	91
1992	-	70**	-	70
1993	-	17	9	26
1994	1	4	16	21
1995	-	10	11	21
1996	Negl	9	10	19

* Totals may not agree due to rounding.
** Until 1993 the fillets category included some tuna fillets.
Source: Japan Tariff Association, *Japan Exports & Imports*, various years.

Appendix J5b.--Japan. Billfish (including swordfish) imports from Chile, by product form, 1986-95

Year	Billfish*		Total	Proportion fillets
	Fillets	Other		
	Metric tons			Percent
1986	-	-	-	-
1987	-	-	-	-
1988	8	-	8	100
1989	32	10	42	76
1990	40	18	58	69
1991	85	6	91	93
1992	70	-	70	100
1993	17	9	26	65
1994	4	17	21	19
1995	10	11	21	48
1996	9	10	19	47

* Japan does not have a separate import category for swordfish, but NMFS believes virtually all the product in the billfish category is swordfish.
Source: Japan Tariff Association, *Japan Exports & Imports*, various years.

Appendix J5c.--Japan. Comparison of Chilean and Japanese billfish/swordfish trade data, 1986-96

Year	Chilean exports	Japanese imports*	Difference
	Metric tons		
1986	NA	-	NA
1987	NA	-	NA
1988	NA	8	NA
1989	NA	42	NA
1990	62	58	4
1991	98	91	7
1992	69	70	-1
1993	48	26	22
1994	29	21	8
1995	18	21	-3
1996	41	19	22

* General billfish import categories, but the authors believe this is mostly swordfish.
Source: Japan Tariff Association, *Japan Exports & Imports*, various years and Subsecretaria de Pesca, unpublished statistics, May 16 and October 3, 1995 and December 10, 1996.

Appendix K1.--Chile. Catch the commercial longline fleet operating in international waters*, by species, 1991-96

Species		Year				
English	Spanish	1992	1993	1994	1995	1996
		Metric tons				
Swordfish	Albacora	563	887	593	272	2,274
Tunas	Atunes					
Albacore	Aleta larga	-	7	10	-	-
Bigeye	Ojos grande	-	20	-	-	-
Yellowfin	Aleta amarilla	1	15	-	2	8
Bonito	Bonito	-	-	-	1	-
Striped marlin	Marlin	-	2	-	-	-
Shark						
Blue	Azulejo	-	72	-	1	-
Mako	Marrrajo	46	160	108	68	93
Amberjack	Vidriola	-	-	-	1	-
Unclassified	No clasificado	-	25	-	-	-
Total		610	1,188	711	345	2,375

Source: SERNAP, *Anuario Estadístico de Pesca*, various years

Appendix K2.--Chile. Tuna catches, 1990-96

Species	Year						
	1990	1991	1992	1993	1994	1995	1996
	Metric tons						
Albacore	306	170	18***	19**	22	15	21
Bigeye	-	5**	-	33**	8*	15	16
Yellowfin	2***	40***	14	82	118*	43	32***
Total	308	215	32	134	148	73	69

Note: Almost all the tuna catch is usually landed in Region V, principally at San Antonio, with the exception of the following notations. Detailed landings data by Region is available in the source.
* Substantial Region VIII landings.
** Substantial catches in international waters.
*** Substantial Region IV landings, principally Coquimbo.
Source: SERNAP, *Anuario Estadístico de Pesca*, various years

Appendix K3a.--Chile. Summary of monthly captures and sightings of leatherback turtles by the San Antonio swordfish fishery, 1988-89

Year	Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
					Number								
1988	3	2	3	-	-	-	1	-	-	-	-	-	9
1989	1	1	6	1	3	9	-	-	-	-	-	-	21
Total	4	3	9	1	3	9	1	-	-	-	-	-	30

Note: The above observations were opportunistic from a single port (San Antonio). One fisheries technician (Mauro González Pino) reports that one vessel, the MFV *Poseidon III*, took six turtles. He estimates that the minumum average catch per vessel is at least one turtle per season. He thus believes that the Chilean driftnet fishery, when several hundred vessels were active, must have been taking several hundred turtles annually.
Source: Jack G. Frazier and José Luis Brito Montero, "Incidental capture of marine turtles by the swordfish fishery at San Antonio, Chile," *Marine Turtle Newsletter*, April, 1990, p. 12.

Appendix K3b.--Chile. Turtle bycatch of artisanal driftnet fishermen, 1988-89

Species	Number
	Number
Leatherbacks	82
Greens	42
Olive Ridleys	21
Loggerheads	5
Total	150

Source: José Brito-Montero, personal communications, March 3, 1997.

Appendix K4.--Chile. Sea lion catch, 1980-96

Year	Quantity
	Metric tons
1980	
1981	
1982	
1983	-
1984	-
1985	-
1986	-
1987	-
1988	47
1989	191
1990	176
1991	56
1992	-
1993	-
1994	-
1995	74
1996	96

Source: SERNAP, *Anuario Estadístico Pesquero*, various years.

Appendix L1.--Chile. Glossary of species

Spanish	English	Scientific
Albacora/pez espada	Swordfish	Xiphias gladius
Anchoveta	Anchovy	Engraulis ringens
Atún	Tuna	Thunnus spp.
Aleta amarilla	Yellowfin	T. albacares
Aleta larga	Albacore	T. alalunga
Barrilete/cachurreta	Skipjack	Katsuwonus pelamis
Ojo grande/patudo	Bigeye	T. obesus
Bacalao*	Cod	
Bacalao de Profundidad	Patagonian toothfish	Dissostichus eleginoides
Bonito	Eastern Pac. bonito	Sarda chiliensis
Caballa	Horse mackerel	Scomber spp.
Calamar	Squid	Loligo
Calamar	Squid	Dosidicus tunicata
????	Squid	Illex spp.
Escamudo	NA	NA
Jurel	Jack mackerel	Trachurus murphyi
Marlines/pez aguja	Marlin/billfish	
Azul/pez zuncho	Blue	Makaira mazara
Rayado	Stripped	Tetrapturus audax
Merluza de cola	Longtailed hake	Macruronus magellanicus
Merluza del sur	Southern hake	Merluccius australis
Mero	Patagonian toothfish	Dissostichus eleginoides
Palometa/dorado de altura	Dolphin/dorado	Coryphaena hippurus
Peje sierra/peto	Wahoo	Acanthocybium solandri
Pez chauchera	Butterfly tuna	Gasterochisma melampus
Pez espada - See albacora		
Pez luna/pez mariposa/opa	Moonfish/opah	Lampris regius/guttatus
Pez sol		
Pez vela/aguja voladora	Sailfish	Istiophorus platypterus
Sardina	Sardine	Sardinops sagax
Tiburones	Sharks	
Azulejo	Blue	Prionace glauca
Galano	Oceanic whitetip	Carcharhinus spp.
Marrajo	Mako	Isurus oxyrinchus
Martillo/cornuda	Smooty hammarhead	Sphyrna zygaena
Quella	NA	NA
Zorro	Bigeye threasher	Alopias vulpinus
Zorro	Common threasher	A. superciliosus
Shrimp	Nailon shrimp	Heterocarpus reedi
Vidriola	Amberjack	Seriola peruana

NA - Not available
* When Chileans refer to cod, they are generally referring to bacalao de profundidad or mero. This should not be confused with the meros in most other Latin American countries, which are groupers.
Source: Various

Appendix L2.--Chile. Glossary of Spanish swordfish fishery terms

Spanish	English
Armador	Vessel owener
Artesanal	Artisanal*
Arpón	Harpoon
Bongos	Small undecked artisal vessels, usually for harpoon fishing
Braza	Fathom or 6 feet (1.83 meters)
Calado	Setting the longline
Cantos	Water areas where mixing of different temperture water is taking place. The water is often whitish in appearance.
Carrete	Reel where the long lime is reteived and stored
Cola	Tail
Concinero	Cook
Curricán	Simple line suspended from a boat using live or artifical bait
Embande	Rigging coefficent
Entrnudo	Mesh size (space between corner knots of each mesh square)
Espinel	Longline
Espinelero	Longliner
Estómago/guata	Stomache or belly flap, depending on the context
Falucho	Small artisanal craft, slightly larger than the bongos
Filete	Fillet or slab, the meat from one side of the fish
Guata	See estómogo
Horquilla	Tail fork
Industrial	Commercial
Interlaced line	Hilo torcido
Lomo	Loin which is half of a chunk (trozado) which is a traversal cut of the fillet
Lonja	See lomo
Luces químicas	Light sticks
Main line	Linea madre
Mandíbula	Mandible
Motorista	Motorist/mechanic
Muesca	Caudal peduncle grove
Ojo	Eye
Panes	???
Palangre	Longline
Palangrero	Longline vessel
Pano	Horizonal section of longline from which the vertical lines with hooks are suspended
Paneles	Individual panels of the drift net
Patrón	Artisanal vessel captain, usually the owner
Pedúnculo	Peduncle
Pescador	Fisherman
Porciones	Portions
Red de pared	Driftnet
Red de enmalle	Driftnet
Reinal	Harpoon fishery: Line connecting the harpoon to the float Longline fishery: Line comecting the baited hook to the motherline
Reinal de flotador	Driftnet fishery: Vertical line from the surface floats to the float line of the drift net
Relinga de caida	Side line or vertical drop of the driftnet
Relinga de flotadores	Upper submerged float line of the driftnet
Relinga de plomos	Bottom or lead line of the driftnet
Tangón	Platform from which harpoons are thrown
Trabajador	Worker/crew member
Tronco	Trunk (headed, eviserated, without tail and dorsal fin)
Trozado/trozo	Chunk, a traversal cut of the fillet including both sides of the lateral line
Virado	Retreival of the longline

* For a definition of artisanal fishing see "Government Policy."
Source: Various.

Appendix L3.--Chile. Glossary of acronyms

Acronym	Extension		Type of Organization
	Spanish	English	
Agencies			
BID	Banco Inter-Americano de Desarollo	IDB	
CEE	Centro de Estudios Espaciales	Center for Space Studies	Goverment
CORFO	Corporación de Fomento	Corporation for Development	Government development promotion company
FIPA	Fondo de Investigaciób Pesquera	Fisheries Research Fund	Goverment research financing fund
IDB	-	Inter-American Development Bank	Internatiomnal development bank
IFOP	Insituto de Fomento Pesquero	Institute for Fisheries Promotion*	Semi-independent research institute
SERNAP	Servicio Nacional de Pesca**	National Fisheries Service*	Government fisheries agency
SSP	Sub-Secretaría de Pesca	Undersecretariat for Fisheries*	Government fisheries agency
Measurements			
DFP	Dias fuera del puerto	Days out of port	
GRT	-	Gross registered ton	
L12D	Longitud primera-segunda dorsal	Length from the first to the second dorsal	
PGON	Peso de la gónada	Gonad weight	
LHMI/LMIH	Longitud horquilla-mandíbula inferior	Length lower mandible to fork	
LHO	Longitud horquilla-ojo	Length fork to eye	
PTOT	Peso total	Total weight	
PTRO	Peso tronco	Trunk weight	
TRB	Tonelad registrado bruto	GRT	
UTM	Unidad tributario mensual	Monthly tax/fine unit	
Other			
PAM	Pesquero del alta mar	Highseas fishing vessel	

* Dependencies of the Ministry of the Economy although IFOP is a semi-autonomous unit.
** SERNAP in 1995 decided to change its designation to SERNAPESCA to stress its conection with the fishing industry.
Source: Various

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